SCIENCE.

FRIDAY, OCTOBER 26, 1883.

THE VIVISECTION QUESTION.

THE book we take as the basis of our remarks,[1] originally published in England, is one of several recent signs that British physiologists are at last coming to their senses; and, instead of attempting to conceal the fact that they experiment on animals, have decided to explain to the general public what a vivisection is, and why vivisections are necessary. Philanthropos, who is evidently well informed, discusses without passion or prejudice such topics as, 'What is pain?' 'What is cruelty?' 'Our rights over animals.' 'What is vivisection?' 'The relation of experiment to physiology,' 'The relation of medicine to experiment,' and so forth. If our colleagues across the water had, some seven or eight years ago, shown sufficient courage to trust to the common sense of the majority of their countrymen, and had endeavored to inform the laity by securing the publication and distribution of some such book as this, the anti-vivisection legislation could hardly have been enacted. Its passage, and the still-continued agitation for an act of Parliament totally forbidding all experiment on living animals, prove that the public did not and does not know enough about the matter to save itself from being misled by the reckless misstatements of irresponsible fanatics, and of certain seekers after notoriety or salary.

People in general do not read official blue-books: so, in spite of the fact that the royal commission appointed to investigate the matter reported, that, after prolonged and careful inquiry, it could find no evidence that English physiologists were guilty of cruelty, it has been possible for certain anti-vivisectors, by a persistent course of malignant vituperation and brazen mendacity, to produce a wide-spread belief that vivisection essentially consists in torturing an animal for the object of seeing how much it can suffer without dying. That such is the actual conviction of many worthy men and women in England, we know to be the case. The physiologists kept silent, and left the field to their enemies, with disastrous result; no one, not a brute, who believed half the stories circulated, could fail to hate physiology and physiologists. When the railroad-stations of England were placarded with large figures of dissections of dead animals, accompanied by printed words designed to entrap the general public into the belief that they represented vivisections of living creatures; when a text-book of practical physiology, designed only for special students of physiology, was represented far and wide as intended for use by every crude medical student; when the fact that the words 'first give an anaesthetic' were omitted (as they are in text-books of surgery, the administration of an anaesthetic being, of course, assumed in cases where very special reasons for its omission do not exist) in the directions for the performance of certain operations, was used as proof that physiologists never thought of employing means to prevent or minimize pain; when a law was passed which allows any one to torture a frog in the most brutal manner if he says he does it just because he likes it, but subjects a university professor to fine and imprisonment if he draws a drop of blood from the animal's toe for a scientific purpose, — then it had certainly become time for the physicians and physiologists of the British Isles to endeavor to inform the public on the vivisection question.

The anti-vivisection craze has now spread to Germany, and there are premonitory symptoms in the United States. Our people in general are too well informed, and have too great confidence in scientific men, to be so easily led

[1] Physiological cruelty; or, fact *v.* fancy: an inquiry into the vivisection question. By Philanthropos. New York, *John Wiley & Sons*, 1883. 156 p. 8°.

astray as the English have been. We shall, moreover, be free from the pressure of a royal court which dislikes biological science, and from the influence of the personal prejudices of the sovereign, still powerful enough in England to have much weight in legislation on questions outside of Whig and Tory politics. Still, American physiology is by no means secure, unless its leaders take warning by the English disaster. They have, in consequence of British legislation, an opportunity to make the United States the chief seat of physiological research among the English-speaking peoples; and it will be a lasting disgrace to them if they let it slip. If, while freely admitting that they believe it their duty to experiment on living animals, they will be on the alert to correct at once the falsehoods and exaggerations of the fanatics; to take pains to teach the public how much the scientific treatment of disease depends on physiological, therapeutical, and pathological research; and to make it widely known how very small a percentage of vivisections involve more pain than that felt by a man on receiving a hypodermic of morphia, — then there is little doubt they will be allowed to carry on without hindrance their beneficent work. The only danger lies in the ignorance of the great majority of ordinarily well-informed people regarding such subjects. Secrecy, not publicity, is what American physiology has to fear.

A HEARING OF BIRDS' EARS.[1] — II.

LET us next confine attention to the ossicles of the ear. Those familiar with these little bones, only as they occur in man or any other mammal, need to be cautioned that their anatomical arrangement, and to a great extent their physiological characters, are very different in birds and other reptile-like vertebrates. Presuming, of course, upon the reader's thorough knowlege of the human case, we will demonstrate these bones in their proper relations and offices in birds, as elements of the lower jaw and hyoid bones (mandibular and hyoidean arches).

The malleus is the proximal element of the meckelian cartilage (figs. 1, 2, *mk*), a gristly rod about which the lower jaw-bone is developed in membrane. Becoming segmented off from the rest of the meckelian rod, it is in mammals withdrawn into the tympanic cavity, disconnected from the jaw-bone, and connected with the incus, its ***processus gracilis*** lying in the glaserian fissure. The jaw-bone then articulates directly with the glenoid cavity of the squamosal, forming the temporo-maxillary articulation. In any bird the malleus remains outside the ear, and acquires comparatively enormous dimensions, with the peculiar shape shown in fig. 1, *q* (see also fig. 2, *q*). This

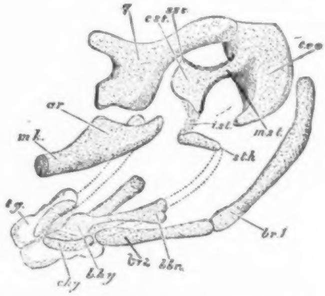


FIG. 2. — The post-oral arches of the house-martin, at middle of period of incubation, lateral view, × 20 diameters. *Mk*, stump of meckelian or mandibular rod, its articular part, *ar*, already shapen; *q*, quadrate bone, or suspensorium of lower jaw, with a free anterior orbital process and long posterior otic process articulating with the ear-capsule, of which *teo*, tympanic wing of occipital, is a part; *mst*, *est*, *sst*, *ist*, *sth*, parts of the suspensorium of the third post-oral arch, not completed to *chy*; *mst*, medio-stapedial, to come away from *teo*, bringing a piece with it, the true stapes, or *columella auris*, the oval base of the stapes fitting into the future *fenestra ovalis*, or oval window, looking into the cochlea, or inner ear; *sst*, supra-stapedial; *est*, extra-stapedial; *ist*, infra-stapedial, which will unite with *sth*, the stylo-hyal; *chy* and *bhy*, cerato-hyal and basihyal, distal parts of the same arch; *bbr*, *br*1, *br*2, basi-branchial, epi-branchial, and cerato-branchial pieces of the third arch, composing the rest of the hyoid bone. (After Parker.)

quadrate bone, as it is called in birds, looks something like an anvil, and has often been mistaken for the incus: on the other hand, from its function in supporting the *membrana tympani* in part, it has been malidentified with the tympanic bone (external auditory process). It is very freely articulated at both ends, rocking back and forth with the movements of the jaws. It normally has articulation with five separate bones: 1. By its lower end, which is bitubercular, with the articular piece of the mandible (lower jaw), forming the true temporo-maxillary articulation; 2. By the outer extremity of its lower end with the quadratojugal bone (fig. 1, *qj*), which is the posterior element of the zygomatic arch, continued forward by the jugal or malar bone (fig. 1, *j*) to the superior maxillary (fig. 1, *mx*); 3. By the inner extremity of its lower end with the ptery-

[1] Continued from No. 34.

goid bone (fig. 1, *pg*), and so with the palate-bone (fig. 1, *pa*) and superior maxillary (*mx*), 4, 5. The head of the bone normally articulates both with the squamosal (fig. 1, *sq*) and with the pro-otic (fig. 4, *po*, here seen inside the cranial cavity). A long spur of the quadrate, its orbital process, projects freely into the orbital cavity, as shown in fig. 1, where the still cartilaginous tip of the orbital process reaches to the round white hole marked *2* (*optic foramen*). Now, the osseous articulations and muscular tractions are such, that, when the mouth is opened, the malleus rocks forward upon its squamosa-petrosal articulation (4, 5, of above enumeration), and pushes upon the zygomatic and pterygo-palatal bars, causing the upper mandible to rise as the lower jaw is depressed; the upper jaw hinging upon elasticity of, or a joint at, the bones of the forehead. Thus the malleus-quadrate is here seen in its proper relation to the jaw-parts as nothing at all of an *ossiculum auditus*, except in so far as it hinges upon parts of the temporal bone, and helps to support the ear-drum. It has no direct connection whatever with the rest of the ossicles.

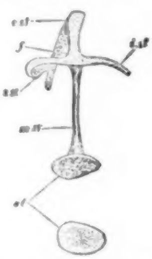


FIG. 3. — Mature stapes of fowl, about × 4. (After Parker.) *st*, its foot, fitting *fenestra ovalis*; *mst*, main shaft, or medio-stapedial element; *sst*, supra-stapedial; *est*, extra-stapedial; *ist*, infra-stapedial, its end representing a rudimentary stylohyal; *f*, a fenestra in the extra-stapedial. (See *st*, *in situ*, fig. 1, and its embryonic formation, fig. 2.)

It will be best to take the stapes next. Fig. 3 shows the mature stapes of the domestic fowl, enlarged about four times, and indicates its several elements which have received special names. It is practically the same bone so named in man, but includes incudial as well as some other elements. In form it is not at all stirrup-like, being trumpet-shaped, with a slender cylindrical shaft, expanded oval foot, and a crossbar and other pieces at the distal end. It is therefore oftener called the *columella auris*, or sounding-post of the ear. In skulls prepared with sufficient care, the stapes may be seen *in situ*, as in fig. 1, *st*, — an extremely delicate rod, stepped into the *fenestra ovalis* by its foot, the other end protruding into the tympanum, and bearing the additional hammer-like or claw-like elements. A stapes I have just picked out of an eagle's ear is a fourth of an inch long, with a stem as fine as a thread of sewing-silk, but a stout foot, and, at the tympanic extremity, a still finer hair-like process half as long as the main stem, from which it stands out at right angles; while there appears to have been another similar claw, which has broken off from such a cross-like object as *st* in fig. 1.

Embryological study is required to demonstrate the stapes as the proximal element of the hyoidean apparatus, quite as the malleus is of the mandibular arch. Reference to fig. 2 should make this clear. Here the malleus, *q*, extends from *teo*, the tympanic wing of the exoccipital, to *ar*, the articular element of *mk*, the meckelian rod whence *q* has been segmented off, leaving the 'temporo-maxillary articulation' between *q* and *ar*. This chain of bones, including others to be developed about and beyond the stump of *mk*, is the lower jaw, or mandibular arch. Now, quite a similar arrangement is shown in the chain of bones in the tongue or hyoidean arch. From *teo* stands off a rod of bone, *m st*, the medio-stapedial element, or main shaft of the stapes, to be segmented away from *teo*, the place of this segmentation to become the fenestra ovalis. The medio-stapedial rod expands at its end; the upper part of the expansion, never separating from the rest, is the supra-stapedial element = mammalian incus, *s st* in figs. 2, 3. An infra-stapedial element, just forming in fig. 2, *ist*, completed in fig. 3, *ist*, connects with the piece marked *st h* in fig. 2. This *st h* is the stylohyal = human 'styloid process of the temporal,' which connects in man by the 'stylo-hyoid ligament,' with the 'lesser cornu of the hyoid bone,' which is the cerato-hyal, *c hy*. In birds, the distal parts of the hyoid arch (composed of the numerous pieces lettered in fig. 2, but which need not longer detain us) become entirely separated from the proximal, the tongue-bones being quite otherwise affixed to the skull; while the proximal parts of the same arch are shut up in the tympanic cavity, where they extend from the *membrana tympani* to the *fenestra ovalis*, constitute all there is of *ossicula auditus*, and consist of the stapes itself (including the several elements specified).

So, therefore, avian malleus or quadrate-bone = human malleus as proximal element of mandibular arch, retaining articular connection with its own arch, but not acquiring character or connections of a human *ossiculum auditus*.

So, therefore, avian stapes or columella = human stapes + incus, as proximal elements of hyoidean arch, not retaining connection with its own arch, but acquiring characters and connections of *ossicula auditus*.

These are the reasons why a bird's lower jaw does not articulate directly with the squamosal,

why the hyoid bones do not articulate at all with the skull, why the malleus is outside the ear, and why there is apparently but one ossicle in the tympanum, of the particular shape shown in fig. 3.

(To be continued.)

THE PSYCHOLOGICAL MECHANISM OF DIRECTION.

WERE it admissible that one person should add to the work of a living author, I might call this paper a supplement to Mr. Francis Galton's Human faculty. My object is to explain the subjective mechanism by which I preserve the consciousness of direction. How far others adopt the same mechanism, I am not fully aware, but am inclined to think that what is fundamentally the same system is employed by nearly every one; but I doubt whether the details are always the same, and the matter appears of sufficient interest to be discussed.

To be conscious which way he is going, one must keep in mind some system of directions. It is true, that, so far as finding one's way about in a place with which he is fully acquainted is concerned, no attention to direction is necessary. One knows that he must turn here to the right, and there to the left, and must follow certain familiar paths, all of which he can do without attending to direction. It is probable that most animals, and possible that some men, have no system except this. Regarding such a limitation as exceptional, we must suppose that in general, men, in going about, have constantly in mind an idea that they are going in a certain definable direction. A direction can, however, be defined only by reference to the direction of some line taken as a standard of reference; and it is this standard of reference, as I have always employed it, which I shall now describe.

I. I continually carry around with me a conception of four horizontal lines, which I shall call co-ordinates, going out in four cardinal directions. I shall call these directions east, west, north, and south; but it must be understood that they have no necessary relation to the actual points of the compass, being purely subjective. This system of co-ordinates is employed, I think, by most or all men.

II. These four cardinal directions are conceived of as *absolute* directions, and not as defined relatively to any particular line on the earth's surface. They have remained unchanged since the earliest memories of childhood. To be more explicit, the ideal or subjective west is the direction in which I was facing, when, as a child, my father explained to me which was the right hand, and which the left; the ideal north is the direction towards which my right side was then turned; the ideal south, that towards which the left side was turned; while east was behind my back.

I have always since imagined myself as conscious of these four absolute directions, and therefore at any moment can face as I imagine myself to have been facing on the occasion referred to. I do not know whether the coordinates have the same absolute character with other men, but think it highly probable that they do, since absolute directions must be more easily thought of than relative ones.

III. With some limitations, to be soon referred to, the system of directions is quite independent of the will. Once fixed in a place, a street, or a house, they are an inseparable component of the situation, and forever unalterable so long as the identity of the place is recognized. Once in a room of which I conceive a certain side to be the absolute west, by no act of the will, and by no consciousness that some other side is the west, can I change the subjective impression. Of course, however, one is liable on going into a strange place, or on walking about without sufficient attention, to be mistaken as to his direction; and thus I am subject to a kind of trouble or confusion which I never heard any one else describe, and which, therefore, I can hardly suppose to be universal. Some instances will illustrate the matter better than general statements.

I recently went to a hotel in Paris, where I had stopped eight years before. While driving into the court, and just as the carriage was stopping, my attention was momentarily occupied in speaking to one of the attendants. Getting out of the carriage, I remarked, as I supposed, that the offices of the hotel had all been moved from the north to the west side of the court. I may anticipate by saying that this was an illusion arising from the very minute circumstance that the carriage, during the moment that I was speaking to the attendant, had turned at a right angle from facing north to facing east; but being unconscious of this change, and not looking around the court, I supposed that the carriage was still directed towards the ideal north. I entered the elevator, was carried to an upper story, shown through several long passages, and into a room, preserving the changed system of coordinates of which I was entirely unconscious. Had it been my first visit to the hotel, no confusion would have resulted, since every thing

around it would have been referred to this same system; but I entertained a distinct idea of the orientation of the rooms around the court as they existed in my mind during my former visit. The result was, that when I went down to dinner I found my co-ordinates 90° wrong. But I was absolutely powerless to refer the two parts of the hotel to the same system. During the week that I remained, whenever I went from my room down-stairs, to the court, the reading-room, or the dining-room, there was a momentary confusion on reaching the point where I saw that the system was wrong. Momentary glances around, and the co-ordinates changed 90°. On returning to my room, the co-ordinates below were carried up-stairs with me, because there was nothing on the stairway with which I had become sufficiently familiar to fix either set of co-ordinates; and thus one system obliterated the other, as it were. In consequence, I could carry one set all the way down, and another set all the way up; the change occurring at the bottom of the stairway in one case, and at the top in the other. The result was, that during my stay I got no clear idea where my room was situated, or what buildings I saw through the window.

To mention another instance: I lived for a number of years in a house in which I must have made a similar mistake the first time I entered it; since, during my whole stay, the orientation inside the building was 90° different from that outside. In the case of such an inconsistency as this, I find that the orientation corresponds to that of the place to which the attention is directed. So long as I was inside a room, or so long as my attention was directed to things inside the house, there was one orientation. On raising the window, and taking a good view of the street, I would perceive that this orientation was 90° in error; and after a momentary confusion the street would assume its right direction. The reverse change would recur on turning back to the room.

I find this occasional inconsistency of orientation, to which I am very liable when I pay no attention to directions on first entering a house, to be really troublesome. It has twice happened quite recently, that, on going upstairs in a hotel on my first arrival, I got the co-ordinates reversed 180°. The result was, that unless I staid long enough to go right by mere habit, without thinking about the direction, I was continually in doubt about which way I should go to find the room I wanted.

IV. I find that this fixity of co-ordinates holds in any kind of a building, and in a ship, but not at all in a carriage, and not absolutely in a railway-car. If I am conscious, by looking at surrounding objects, that a railway-car turns 90°, I can change its relation to the system of co-ordinates accordingly. It appears, therefore, that it is only in fixed structures that the co-ordinates inure in my conceptions of enclosed space; yet I feel perfectly sure, that, if a house in which I lived be turned through 90° or 180°, the system would turn with it, in spite of any thing I could think to the contrary.

V. I now come to the modifications of fixity to which I have already referred. The imaginary sense of direction is not absolutely always present. In travelling over a new road to a new place, the sense of direction is, for the time being, apt to be lost. In this case, and in this alone, it is to a certain extent under control of the will; but, if the will fails to act promptly on arriving at a place, the co-ordinates fix themselves, as it were, and that quite arbitrarily, so far as I have been able to perceive. Once fixed, they stay. But, while under control of the will, I am in the habit of so directing them that the ideal directions shall correspond to the points of the compass, in case I know them.

VI. I have recently noticed that it is not necessary that I should actually have seen a place, in order that the co-ordinates should be fixed in it. If I study on a map a place which I am to visit, I unconsciously fix the co-ordinates to correspond to the points of the compass. Thus, on arrival, I readily find my way about. But it may happen, that, when I arrive, I am mistaken as to the direction in which the railway-station stands. Then, take what pains I will, the same confusion arises when I arrive at a street or hotel which I have studied on the map, and find the co-ordinates to be wrong. The directions change to those in which I have thought of the house or street.

Of this fixing of the co-ordinates in advance, I recently had a curious example. I got on board a steamship at Liverpool, resolving that the ideal and real west on board ship should correspond. I went down to seek out my state-room, and, on returning to the deck, I was chagrined to find that the co-ordinates had got changed 180°. In consequence, I had to think before knowing which side of the ship I looked at. For some time I was puzzled to imagine how the mistake could have occurred. I finally traced it to the fact, that, on studying the position of my state-room on the plan of the ship a month before, I had held up the

plan with the stern in the direction in which west is on the map. I constructed the orientation of the passageway and of the stateroom accordingly. It happened, that, when I joined the ship, her stern was towards the east; but, on descending into the cabin for the first time, I fixed the orientation to correspond to the one previously formed from the plan, forgetting at the moment that I was thus making a change of 180°.

VII. A universal law of the four cardinal directions is, that they always arrange themselves along visible lines, such as roads, boundaries of a room, etc.: in other words, the directions never subdivide themselves. In going along a new road which I know ought to bisect the angle between two directions, I can, by an effort of the will, imagine it to do so; but, the moment attention is relaxed, one cardinal direction is sure to take possession of the road, and of course, once in possession, keeps it: so, no matter how well I may know that the walls of a room are at an angle of 90° with the other walls of a building, the directions are sure to arrange themselves parallel to the walls.

It may be asked, How does this system work, in case of a number of rooms radiating like a fan from a central space? I answer, that in such a case my ideas of direction simply get unutterably confused, and only by long habit can I get the relations of the different rooms to each other. SIMON NEWCOMB.

THE ARAGO LABORATORY AT BANYULS.

AMONG the zoölogical stations or laboratories along the coast of France, none is more widely known or more firmly established than the laboratory at Roscoff,[1] in Finisterre, organized in 1872 by Professor Lacaze-Duthiers as an adjunct of his zoölogical laboratory of the Sorbonne at Paris. Encouraged by the success of his laboratory at Roscoff, which during August, 1881, had twenty-five workers, but which, owing to its exposed position at the north-west extremity of France, was only available for work from March until October, at the most, Professor Lacaze-Duthiers sought to establish a winter laboratory on the Mediterranean, to furnish seaside work the remaining months of the year. After careful examination of the French coast of the Mediterranean, a location was chosen for the laboratory at the base of the rocky promontory of Fontaulé, at the entrance of the little harbor of Banyuls-sur-mer, within a few miles of the Spanish frontier in the department of Pyrénées-Orientales.

The municipal council of Banyuls, through the mayor, M. Pascal, who took much interest in the establishment of the laboratory, offered a site for building, twelve hundred francs for immediate use, and an income of five hundred francs annually for twenty years; M. Thomas, a wealthy gentleman of Banyuls, offered two hundred and fifty francs annually for ten years, and a boat; the council of the department of Pyrénées-Orientales voted twenty thousand francs toward the construction of the laboratory; and subscriptions were received from the citizens of this rich wine-producing neighborhood. These were some of the means employed to induce Professor Lacaze-Duthiers to locate at Banyuls. Port Vendrès, a neighboring village, offered inducements to locate there; but the great number of fishermen in Banyuls, its nearness to the open Mediterranean, and its freedom from the distractions due to commercial and other activities, together with the earnest interest taken by its inhabitants in the laboratory, won the choice of that village. What a novel sight it would be, here in America, to see villages contesting for the honor of possessing a scientific laboratory! The Academy of sciences at Paris took the laboratory under its protection; and the establishment was called 'Laboratoire Arago,' to honor the name of the most distinguished *savant* of the Pyrénées-Orientales, a former member of the academy.

It is, of course, impossible to speak of much work already accomplished at the Arago laboratory, as one might describe studies completed at Roscoff; for the laboratory at Banyuls was scarcely finished in the winter of 1881–82, when, with another American and a French student, I had the pleasure of being one of the first to work within its walls: so I will write only of the region and of the laboratory.

The eastern end of the Pyrenees descends suddenly upon a north and south coast by a series of radiating ridges, between which are small indentations of the sea, forming harbors, with rocky promontories at each side of their entrances, and a sandy beach within. This kind of coast offers numerous advantages to those searching for marine animals. On each of the larger of the beaches are villages, most of which date back to Roman times. These villages were recently connected by a railroad which follows the coast, passing through tunnels between them.

Banyuls is situated upon one of these beaches, at the head of a small harbor, which is partly

[1] For a detailed account of the laboratory at Roscoff, with maps and plans, see *Revue scientifique*, Nov. 26, 1881, xxviii. 673–680.

protected from the open sea by a breakwater (seen in the middle of the first picture at the left of the laboratory), which extends from the promontory, at the base of which the laboratory is built, to a rocky island in the middle the entrance to the harbor. The village of Banyuls itself (seen in the other illustration, looking from the laboratory into the harbor) has about four thousand inhabitants. Behind the village the hills are clothed with vineyards, olive-groves, and cork-oak trees, nearly to their tops. To crown the view is the middle-age tower of Madeloth, or *Tour du Diable*, on a mountain six hundred and sixty-eight metres high. The village has two hotels, which are crowded with bathers during midsummer. In winter there are few amusements, and the hotels are then nearly empty. For a good concise description and history of this region, in which the Catalan dialect still prevails to a considerable extent, and the history of which is extremely interesting, I refer to Pierre Vidal's ***Guide historique et pittoresque dans le département des Pyrénées - Orientales***, Perpignan, 1879. M. Vidal is the assistant librarian of the town of Perpignan, capital of the department.

The climate of Banyuls is sufficiently moderate to make a winter's stay very agreeable. Oranges, figs, cactuses, almonds, and even the date-palm with poorly developed fruit, are cultivated in the valleys. In the latter part of February, 1882, I waded along the beaches in search of mollusks, without finding the cold inconvenient. Snow rarely falls. The climate can be shown best by quoting a table for 1882, from Martinet,[1] as follows (*degrees in Centigrade*) : —

MONTH.	TEMPERATURE.					NUMBER OF DAYS OF	
	EXTREMES.		MEANS.				
	Minimum.	Maximum.	Minimum.	Maximum.	Total.	Rain.	Wind.
January	2.0	15.0	5.0	11.7	8.4	3	1
February . . .	1.5	19.5	6.4	13.1	9.7	3	7
March	4.0	23.0	9.3	16.9	13.1	5	9
April	7.5	26.0	10.6	18.6	14.6	8	7
May	10.0	27.5	14.7	22.7	18.7	3	3
June	13.5	34.5	17.6	26.5	22.1	4	9
July	16.0	38.5	19.3	28.3	23.8	3	11
August	13.0	35.0	19.9	28.1	24.0	7	6
September . . .	10.5	28.0	12.9	20.4	17.1	13	2
October	9.5	27.0	13.3	19.8	16.5	6	8
November . . .	5.0	19.0	8.7	15.5	12.1	4	8
December . . .	1.0	16.0	6.7	11.6	9.2	8	3
Means of the year,	-	-	12.1	19.4	15.8	67	74

[1] L. Martinet, Banyuls sur mer (*Rev. géogr. internat.*, April, 1883, 8e ann , 67).

The lowest temperature of which I find data was — 6° C., in January, 1871. The cold winds which sometimes descend from the mountains, blowing with considerable severity for one or two days at a time, are the only unpleasant climatological feature of the region.

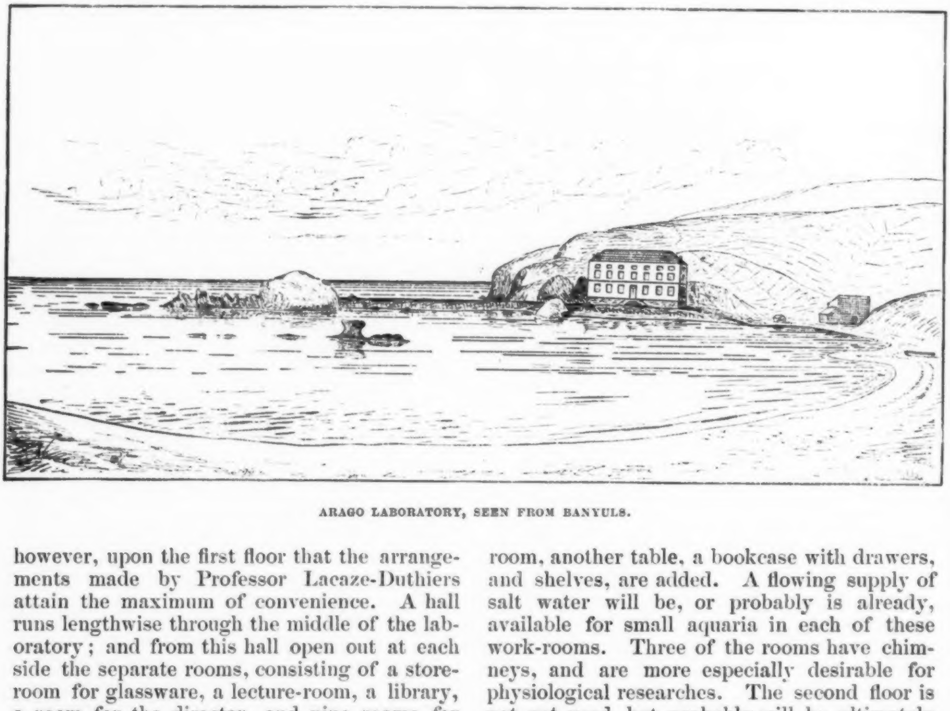
I have been unable to find sufficient data in regard to the temperature of the sea-water at Banyuls. Martinet writes (*l. c.*, May, 1883, p. 85), "From the month of May the temperature of the sea is 18° ; that of the air, in the shade, from 30° to 35°. In July and August the temperature of the water reaches 24° to 26° ; then in September and October it descends from 22° to 18°."

The marine fauna at Banyuls is very rich. Several species of corals and of actinias, and numerous species of interesting mollusca, such as Chiton and Haliotus, can be taken on the rocks within a few metres of the laboratory. Besides these, the janitor in charge regularly transplants new species to the vicinity of the laboratory. Siphonophores, ctenophores, and tunicates swarm in the waters. It would be useless to mention here the numerous forms which are found on every side without the aid of the dredge; and, when the dredge is used, the result is almost incredible. Add to this the habit already acquired by the fishermen of bringing to the laboratory all curious animals which they find in their nets, and we have a place where unsurpassed opportunities are offered for obtaining material in quantity for study, an opportunity of which I availed myself, in order to study the parasites of fishes and crustaceans. The fishing at Banyuls, excepting that for sardines and anchovies, is carried on by the use of a large funnel-shaped net, held open, and drawn through the water by two boats, which stand a distance apart. Numerous sharks and cephalopods, — both eaten by the people at Banyuls, — and sometimes sunfishes (Orthagoriscus) and other large fishes, are taken in these nets, besides smaller fishes by thousands.

About fifty fishing-boats, like those seen in the second illustration, leave Banyuls early every pleasant morning, returning about five o'clock in the afternoon, when the fish are spread out for sale along the beach. This mode of sale is a convenience for the naturalists as well as for the townspeople : on the contrary, in fishing-places near large cities, the fish are hurried aboard the trains, leaving no opportunity for their examination. The fresh entrails of fishes can be examined by thousands on the beach at Banyuls, for parasites or for anatomical purposes.

The terrestrial and aerial fauna offers abundance of water-birds, lizards, geckoes and insects, scolopendra and scorpions.

The Arago laboratory is a brick and stone building, about forty metres long and ten metres wide, facing nearly northward. The illustration is a view of the laboratory looking nearly southward from the village. The ground-floor of the laboratory is devoted to a small room for the janitor, another for apparatus, and to a large room for aquaria. In the centre of the last room is a large oval aquarium, and about the room are smaller aquaria to be devoted to special purposes. The water from these aquaria passes out of the front of the building, and supplies other aquaria in the open air. It is, however, upon the first floor that the arrangements made by Professor Lacaze-Duthiers attain the maximum of convenience. A hall runs lengthwise through the middle of the laboratory; and from this hall open out at each side the separate rooms, consisting of a storeroom for glassware, a lecture-room, a library, a room for the director, and nine rooms for work. Instead of having a table, as is the usual mode in laboratories, each worker has a room (four metres square) to himself, wherein he can carry on researches undisturbed by his neighbors. As the laboratory is intended for advanced students pursuing original investigations, this provision is of special importance. Sitting on a revolving-chair in the middle of his room, the worker has upon his right a table for drawing; in front, toward the large window, — which, with the climate of Banyuls, can be open much of the time, — is a table for his microscope and apparatus; at his left, a table for specimens. Turning to his right, the investigator can write his notes and draw, free from the danger of water from his larger specimens. This arrangement of tables in three sides of a square, with a revolving-chair at the centre, is an idea original, as far as zoölogical laboratories are concerned, with Professor Lacaze-Duthiers; and, after having used for a time tables thus arranged, one never is exactly at ease when they are placed otherwise. As if these were too meagre furnishings for each room, another table, a bookcase with drawers, and shelves, are added. A flowing supply of salt water will be, or probably is already, available for small aquaria in each of these work-rooms. Three of the rooms have chimneys, and are more especially desirable for physiological researches. The second floor is not yet used, but probably will be ultimately partitioned into sleeping-rooms for those who work in the laboratory.[1]



ARAGO LABORATORY, SEEN FROM BANYULS.

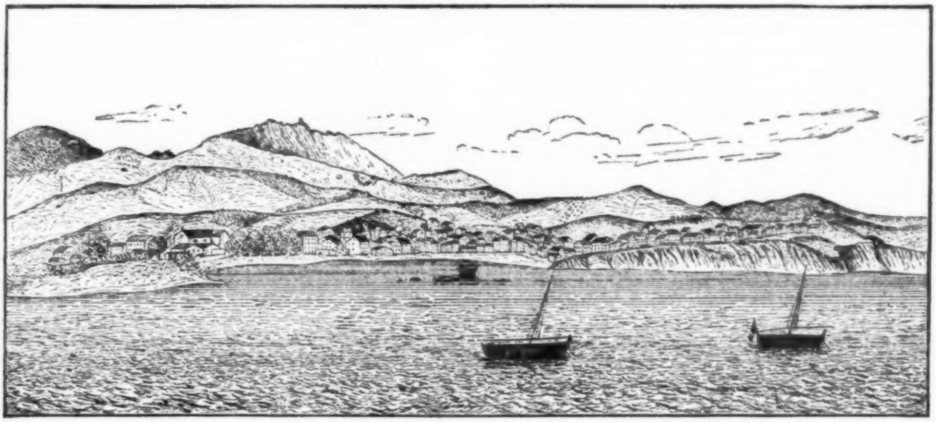
The laboratory possesses already, besides two rowboats for collecting along the indentations of the coast, a new boat of the same general construction as are the fishing-boats of

[1] For a detailed description and plans of the Arago laboratory, see the *Revue scientifique*, Dec. 3, 1881, xxviii. 705–715.

the region, with a lateen-sail, but considerably larger for long voyages. This boat is commanded by an experienced fisherman of Banyuls, who is conversant with the whole neighboring coast.

The almost entire absence of rise and fall of the water at Banyuls at first puzzles a collector of marine animals accustomed to searching the rocks bared by the receding tide: but one soon finds other and equally productive modes of shore-collecting; while the very absence of great variation in the level of the water enables one to moor boxes of embryos along the inside of the breakwater, and watch their development at leisure.

The expenses of living in Banyuls are about what they would be in a village of the same



BANYULS AS SEEN FROM THE LABORATORY.

size on the New-England coast; but the laboratory, like that at Roscoff, is free, requiring for its use only the permission of Professor Lacaze-Duthiers. Reagents, microscopes, mounted dissecting-lenses, glassware, and all other necessary apparatus, are furnished free, the only cost being a small fee paid to the janitor for the care of rooms. While, in all probability, preference would be rightly given to Frenchmen, in case there were more applicants for places than there were rooms, yet foreign investigators will undoubtedly play an important part in the laboratory at Banyuls, as they have already done in that at Roscoff, and will return to their native countries vividly impressed with the liberality and devotion to science shown by Professor Lacaze-Duthiers.

GEO. DIMMOCK.

AUGUST REPORTS OF STATE WEATHER-SERVICES.

THE states in which organized weather-services exist have issued reports for August which give in some detail the results of the observations. The special feature of the month in the majority of states seems to have been the lack of rain, and the consequent drought.

Georgia. — The temperatures ranged from 47° to 98°: the mean was 79°.3. The rainfall ranged from 1.01 inches in the south-west to 9.15 inches in the south-east. The general drought of the summer was unbroken. The cotton and corn crops do not average 75 % of the usual yield.

Indiana. — Thunder and lightning were unusually prevalent, but the rainfall was at least one inch less than the average. The temperatures were lower than usual, and light frosts were reported on the 24th and 25th. The pressure was nearly normal, with a small range.

Iowa. — "The month was cold, clear, dry, with north-westerly and south-easterly winds equally frequent, and calms numerous." The low mean temperature, 2°.5 below the normal, is mainly due to the first decade; but in this period the sunshine was especially intense. The number of fine days, and the dry, sunny weather, have been favorable to the crops. Frosts were recorded on the 22d, 23d, and 24th. There was a very severe hail-storm on the 7th, extending from Sac to Cass counties.

Missouri. — The mean temperature was below the normal, at St. Louis 2°.3 lower. The rainfall was less than the average, the amount at the central station in St. Louis being not much more than half the usual quantity. The heaviest rainfall was on the southern border of the state. In consequence of the continued drought, the crops have suffered much. A few wind and hail storms were reported.

Nebraska. — There are thirty-one observers, from whose reports it is found that the temperature and rainfall were about normal. The average mean temperature was 75°.4; average rainfall, 3.43 inches. The highest of the maximum temperatures was 93°; the lowest of the minimum, 47°. A violent hail-storm occurred on the 8th, at Lincoln; and a wind of forty four miles per hour, from the east, was noted at North Platte.

Ohio. — The barometric pressure was unusually steady, the small range of 0.542 inches being noted. The mean temperature, 68°.2, is more than four degrees below the average. A minimum of 39° was noted. Rain fell on seven days only. The average rainfall was only 1.88 inches, the usual amount being 3.47 inches. At Lebanon 4.60 inches fell, and at Granville 0.70 inch. A violent storm of wind and hail visited Wooster and vicinity on the 28th.

Tennessee. — The reports are from thirty-five stations. The highest of the maximum temperatures noted was 94°, and the lowest of the minimum 43°. The ranges of temperature were generally uniform throughout the state; but the precipitation, which ranged from 1.03 to 6.38 inches, was quite unevenly distributed. The weather presented no remarkable features. There was a marked absence of high winds or severe electrical disturbances. The crop reports are excellent, but the average condition is a little below that of last year.

THE GEOGRAPHIC CONTROL OF MARINE SEDIMENTS.

M. A. RUTOT, conservator in the Royal museum of natural history of Belgium, who, in connection with M. E. Van den Broeck, has been studying the tertiary strata of his country, has lately taken up (*Bull. mus. roy. hist. nat. Belg.*, ii. 1883, 41) the fruitful subject of the immediate dependence of fragmental marine deposits on geographic conditions, such as distance and form of shore-line, depth of water, currents, etc., and the consequent changes in these deposits following changes in the controlling geographic surroundings. The matter is properly treated deductively, and so far as concerns vertical oscillations of the earth's crust, which determine advance and retreat of the shore-line, it is examined with much detail. The conclusion is reached, that the frequent changes from gravels, through sands to clays, and back again to gravels, that characterize the Belgian tertiaries, can be fully explained by simple, assignable, and slow geographic causes. We have only to regret, that, in the forty pages devoted to the subject, more room was not found for mention of what others have done in the same direction. The method of investigation may be outlined as follows: —

There is first given the familiar illustration of the varied deposits forming off shore at any single time, showing that the texture, and, in part, the composition of the deposits, are functions of the distance from the shore-line, as in fig. 1. Now, let a general depression slowly take place, by which the sea will advance over the land: the whole set of deposits shifts with the shore, until sands, and at last clays, are laid down over the first gravels, as in fig. 2. Then, if elevation replace the depression, the set of strata shifts seaward, and the sands, and at last the shore-gravels, lie above the clays, as in fig. 3. It is generally noted that the upper gravels are finer than the lower, as the later deposits are made, in part, by working over the older during the time of emergence.

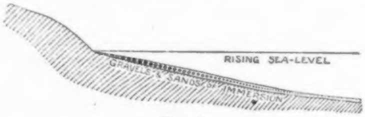


FIG. 1.

The complete set of deposits formed during such a double oscillation of sea-level is to be considered in two ways, — first, with regard to the vertical sequence of the strata; second, with regard to their horizontal equivalence. The vertical sequence is seen in fig. 4: it is made up of the gravels and sands of immersion, the central layer of clay, and the sands and gravels

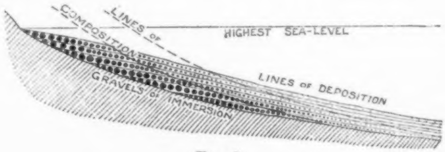


FIG. 2.

of emersion, each stratum having its appropriate fossils. Such 'circles of deposition,' enlarged by the addition of a limestone at the time of greatest distance of the old shore-line, occur several times in our Appalachian sections; and the recognition of their meaning, especially in Professor Newberry's luminous writings, has thrown much light on the evolution of our country. M. Rutot gives the accompanying figure (5) to illustrate the succession of unequal or incomplete oscillations: it shows, I., a large and complete

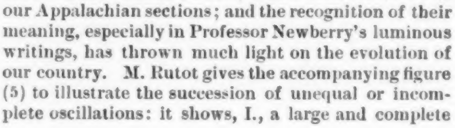


FIG. 3.

oscillation, partly eroded before II., a second depression, from which the elevation was incomplete; III., a great depression and complete elevation; IV., a moderate depression and elevation. This complicated succession represents perfectly the type of the Belgian tertiaries; and the deductions from its physical features are fully confirmed by the evidence from its fossils.

The second consideration, involving the horizontal equivalence of the different strata, is perhaps the most suggestive part of the paper. It is of much importance, and is seldom sufficiently treated. It

involves the further examination of the dependence of a set of phenomena on their distance from some controlling condition, which can be called the directrix, and which may change its position. This is worthy of illustration. We find a simple case, in which the directrix is motionless, in the escape of

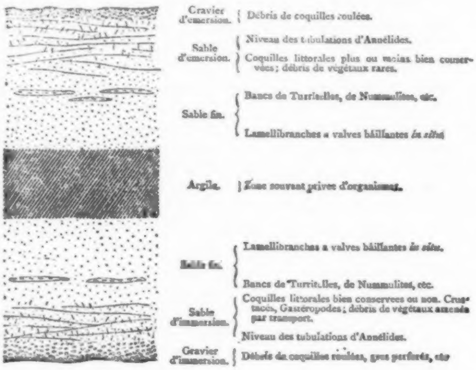


FIG. 4.

gases during a volcanic eruption. The eruptive vent is the directrix, and the various gases are successively given off from the lava when its temperature falls to that below which they cannot be occluded, the temperature depending largely on the distance of flow from the crater. An example in which the directrix moves continually in one direction is seen in the dependence of terrestrial day and night, with all their attendant changes, from warmth to cold, activity to rest, on the position of the sun. One in which the directrix moved for a time in one direction is seen in the relation of our drift-deposits to the

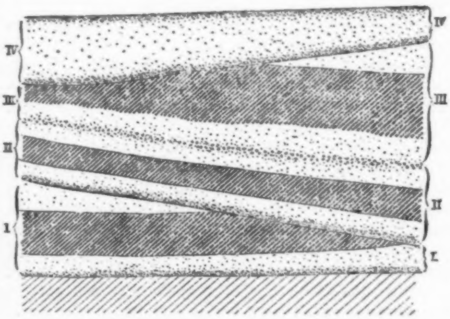


FIG. 5.

'retreating' margin of the continental ice. Far to the northward of the margin, where the ice was thickest and moved fastest, erosion was most active; at a less distance, the ground-moraine was accumulated at favorable points; at the margin, the Kame gravels were deposited; and farther south, the brick-clays settled where they found quiet water: hence all these may be chronologically equivalent in passing from south to north, although at a given point we should find a vertical sequence from scratched rock, through ground-moraine and Kame gravels to brick-clay. An effect of irregular motion of the directrix will be seen in the shifting of all those physical and chemical actions going on within the earth, and dependent for their proper temperatures and pressures on their depth below the surface; for this depth, or the distance from their directrix, is continually, though very slowly and irregularly, changing, — decreasing, while the superincumbent mass culminates in a land-surface that is losing ground by erosion; increasing, while it is receiving new material below the sea. A regular oscillation of the directrix is presented in the swinging of the sun north and south of the equator, carrying the seasons, the wind-systems, and the length of the day, in its train. Finally, the case in point shows us an irregular shifting of the shore-line directrix as the land slowly rises and falls. As a first result of the dependence of deposits on their distance from the shore-line, we shall find that those formations which are at any given moment contemporaneous, or horizontally equivalent, are the very ones already seen at any given point in vertical sequence. Secondly, when we view a broad set of deposits accumulated during a shifting of the shore-line, it will be seen, that while the band of conglomerate or sandstone is continuous for considerable distances, and apparently of contemporaneous formation throughout, it is not so in reality; for the lines of composition are not lines of deposition, and one part of the conglomerate is distinctly of later date than another, and really contemporaneous with the clay overlying the latter. This is illustrated in fig. 2, and shows the complete abandonment of the old ideas concerning universal formations. Instead of supposing that contemporaneous deposits are of uniform composition throughout, we must now admit that they necessarily vary.

M. Rutot's paper was prepared especially for the explanation of Belgian geology. Before it could serve as a guide to the meaning of our broad paleozoic strata, there should be added a consideration of the geographic conditions of limestone-making, and of the former greater strength of transporting agencies required by our old conglomerates. It would have been well to consider Phillips's suggestion concerning continuous subsidence at irregular rates, in which the shallowing is produced by deposition instead of by elevation; for, although this is quite inadequate to explain the changes in the heavy Appalachian sediments, where shallow-water sandstones sometimes quickly follow deep-water limestones or shales, it may serve in certain cases of smaller measure, which M. Rutot has interpreted as the effects of oscillations. On the other hand, the occurrence of elevation after and in spite of deposition might be emphasized to show the rather one-sided aspect of the conclusions lately discussed by the English geologists, who too often consider erosion and deposition as almost the chief causes of change of level.

THE DEVONSHIRE CAVERNS, AND THEIR CONTENTS.[1]

ANTHROPOLOGY, on one of its numerous sides, marches with geology; and hence it is, no doubt, that I, for many years a laborer very near this somewhat ill-defined border, have been invited to assist my friends and neighbors in the work which lies before them during the association week. I have the more cheerfully accepted the invitation, from a vivid recollection, that, when on a few occasions I have come uninvited into this department, my reception has been so very cordial as to lead me to ask myself whether the reports which for many years (1864 to 1880) I laid annually before my geological brethren did not derive their chief interest from their anthropological bearings and teachings.

In 1858, a quarter of a century ago, I had the pleasure of reading to the geological section of the association the first public communication on the exploration, then in progress, of Brixham Cavern (more correctly, Brixham Windmill-hill Cavern); and as any interest connected with that paper lay entirely in the evidence it contained of the inosculation and contemporaneity of human industrial relics of a rude character, with remains of certain extinct mammals, I purpose on this occasion to lay before the department a few thoughts, retrospective and prospective, which may be said to radiate from that exploration, confining myself mainly to South Devon.

Probably nothing will better show the apparent apathy and scepticism with which, up to 1858, all geological evidence of the antiquity of man was received by British geologists generally, than the following statement of facts:—

About the beginning of the second quarter of the present century, the late Rev. J. MacEnery made Kent's Cavern, or Kent's Hole, near Torquay, famous by his researches and discoveries there. He not only found flint implements beneath a thick continuous sheet of stalagmite, but, after a most careful and painstaking investigation in the presence of witnesses, arrived at the conclusion that the flints "were deposited in their deep position before the creation of the stalagmite" (*Trans. Devon. assoc.*, iii. 330); and when it was suggested by the Rev. Dr. Buckland, to whom he at once and without reservation communicated all his discoveries, that "the ancient Britons had scooped out ovens in the stalagmite, and that through them the knives got admission to the 'diluvium,'" he replied, "I am bold to say that in no instance have I discovered evidence of breaches or ovens in the floor, but one continuous plate of stalagmite diffused uniformly over the loam" (*Ibid.*, p. 334). He added, "It is painful to dissent from so high an authority, and more particularly so from my concurrence generally n his views of the phenomena of these caves, which three years' personal observation has in almost every instance enabled me to verify" (*Ibid.*, p. 338).

It is perhaps not surprising that Dr. Buckland, one of the leading geologists of his day, should be too tenacious of his opinion, and feel too secure in his position to yield to the statements and arguments of his comparatively young friend, MacEnery, then scarcely known to the scientific world.

That the position taken by Buckland retarded the progress of truth, and was calculated to check the ardor of research, is apparently certain, and much to be regretted. But it should be remembered, that, at least as early as 1819, he taught that "the two great points . . . of the low antiquity of the human race, and the universality of a recent deluge, are most satisfactorily confirmed by every thing that has yet been brought to light by geological investigations" (Vindiciae geologicae, p. 24); that early in 1822 he reiterated and emphasized these opinions in his famous Kirkdale paper (*Phil. trans.* for 1822, pp. 171–236), which the Royal society 'crowned with the Copley medal' (*Quart. journ. geol. soc.*, vol. xiii. p. xxxiii.); that in 1823, having amplified and revised this paper, he published it as an independent quarto volume under the attractive title of 'Reliquiae diluvianae,' of which he issued a second edition in 1824; and that though his acquaintance with Kent's Cavern was much less intimate than that of MacEnery, he nevertheless was, of the two, the earlier worker there, and, in fact, had discovered a flint implement in it before MacEnery had ever seen that or any other cavern, — the first tool of the kind found in any cavern, it is believed, and which in all probability was met with under circumstances not in conflict with his published opinion on the low antiquity of man. I confess that under such circumstances, human nature being what it is, the line followed by Dr. Buckland seems to me to have been that which most men would have pursued.

It was, at any rate, the line to which he adhered as late, at least, as 1837; for in his well-known 'Bridgewater treatise,' published that year, after describing his visit to the caverns near Liége, famous through the discoveries of Dr. Schmerling, he said, "The human bones found in these caverns are in a state of less decay than those of the extinct species of beasts: they are accompanied by rude flint knives, and other instruments of flint and bone, and are probably derived from uncivilized tribes that inhabited the caves. Some of the human bones may also be the remains of individuals, who, in more recent times, have been buried in such convenient repositories. M. Schmerling . . . expresses his opinion that these human bones are coeval with those of the quadrupeds of extinct species, found with them, —an opinion from which the author, after a careful examination of M. Schmerling's collection, entirely dissents" (*Op. cit.*, i. 602).

It may be doubted, however, whether his faith in these his early convictions remained unshaken to the end. I have frequently been told by one of his contemporary professors at Oxford, who knew him intimately, that Buckland shrank from the task of preparing for the press new editions of his 'Reliquiae diluvianae' and his 'Bridgewater treatise.' 'The work,' he said, 'would be, not editing, but re-writing.'

[1] Address by WILLIAM PENGELLY, F.R.S., F.G.S., vice-president of the section of anthropology of the British association for the advancement of science. From *Nature*.

Mr. MacEnery intended to publish his 'Cavern researches' in one volume quarto, illustrated with thirty plates. In what appears to have been his second prospectus, unfortunately not dated, he said, "The limited circulation of works of this nature being by no means equal to the expenses attendant on the execution of so large a series [of plates], the author is obliged to depart from his original plan, and to solicit the support of those who may feel an interest in the result of his researches."

There is reason to believe that at least twenty-one of the plates were ready, and that the rough copy of much of his manuscript was written, but that, the support he solicited not being forthcoming, the idea of publishing had to be abandoned (see *Trans. Devon. assoc.*, iii. 198–201).

In 1840 Mr. R. A. C. Austen, F.G.S. (now Godwin-Austen), read to the Geological society of London a paper on the bone-caves of Devonshire, which, with some amplifications, was incorporated in his memoir on the geology of the south-east of Devonshire, printed in the transactions of the society in 1842 (2d ser. vi. 433–489). Speaking of his own researches in Kent's Cavern, he said, "Human remains, and works of art, such as arrow-heads and knives of flint, occur in all parts of the cave, and throughout the entire thickness of the clay; and no distinction founded on condition, distribution, or relative position, can be observed whereby the human can be separated from the other reliquiae" (*Ibid.*, p. 444).

He added, "My own researches were constantly conducted in parts of the cave which had never been disturbed, and in every instance the bones were procured from beneath a thick covering of stalagmite. So far, then, the bones and works of man must have been introduced into the cave before the flooring of stalagmite had been formed" (*Ibid.*, p. 446).

Though these important and emphatic statements were so fortunate as to be committed to the safe keeping of print with but little delay, and under the most favorable circumstances, they appear neither to have excited any interest, nor, indeed, to have received much, if any, attention.

In 1846 the Torquay natural history society appointed a committee, consisting of Dr. Battersby, Mr. Vivian, and myself, — all tolerably familiar with the statements of Mr. MacEnery and Mr. Austen, — to make a few diggings in Kent's Cavern for the purpose of obtaining specimens for their museum. The work, though more or less desultory and unsystematic, was by no means carelessly done; and the committee were unanimously and perfectly satisfied that the objects they met with had been deposited at the same time as the matrix in which they were inhumed. At the close of their investigation they drew up a report, which was printed in the Torquay directory for Nov. 6, 1846 (see *Trans. Devon. assoc.*, x. 162). Its substance, embodied in a paper by Mr. Vivian, was read to the Geological society of London on May 12, 1847, as well as to the British association in the succeeding June; and the following abstract was printed in the Report of the association for that year (p. 73): —

"The important point that we have established is, that relics of human art are found *beneath* the unbroken floor of stalagmite. After taking every precaution by sweeping the surface, and examining most minutely whether there were any traces of the floor having been previously disturbed, we broke through the solid stalagmite in three different parts of the cavern, and in each instance found flint knives. . . . In the spot where the most highly finished specimen was found, the passage was so low that it was extremely difficult, with quarrymen's tools and good workmen, to break through the crust; and the supposition that it had been previously disturbed is impossible."

It will be borne in mind that the same paper was read the month before to the Geological society. The council of that body, being apparently unprepared to print in their *Quarterly journal* the statements it contained, contented themselves with the following notice, given here in its entirety (*Op. cit.*, iii. 353): —

"'On Kent's Cavern, near Torquay,' by Mr. Edward Vivian. — In this paper an account was given of some recent researches in that cavern by a committee of the Torquay natural history society, during which the bones of various extinct species of animals were found in several situations."

It will be observed that the 'flint knives' were utterly ignored, — a fact rendered the more significant by the following announcement on the wrapper of the journal: "The editor of the *Quarterly journal* is directed to make it known to the public that the authors alone are responsible for the facts and opinions contained in their respective papers."

Such, briefly, were the principal researches in Kent's Cavern, at intervals from 1825 to 1847. Their reception was by no means encouraging: Mr. MacEnery, after incurring very considerable expense, was under the necessity of abandoning the intention of publishing his 'Cavern researches;' Mr. Austen's paper, though printed unabridged, was given to an apathetic, unbelieving world, and was apparently without effect; and Mr. Vivian's paper, virtually the report by a committee of which he was a member, was cut down to four lines of a harmless, unexciting character.

For some years nothing occurred to break the quietude, which, but for an unexpected discovery on the southern shore of Torbay, would probably have remained to this day.

Early in 1858 the workmen engaged in a limestone-quarry on Windmill Hill, overhanging the fishing town of Brixham in South Devon, broke unexpectedly a hole through what proved to be the roof of an unknown and unsuspected cavern. I visited it very soon after the discovery, and secured to myself the refusal of a lease, to include the right of exploration. As the story of this cavern has been told at some length elsewhere (see *Phil. trans.*, clxiii. 471–572; or *Trans. Devon. assoc.*, vi. 775–856), it will here suffice to say, that at the instance of the late Dr. H. Falconer, the eminent paleontologist, the subject was taken up very cordially by the Royal and geological societies of London, a committee was appointed by

the latter body, the exploration was placed under the superintendence of Mr. (now Professor) Prestwich and myself, and, being the only resident member of the committee, the actual superintendence fell of necessity to me.

The following facts connected with this cavern were, no doubt, influential in leading to the decision to have it explored: —

1. It was a virgin cave which had been hermetically sealed during an incalculably long period, the last previous event in its history being the introduction of a reindeer antler, found attached to the upper surface of the stalagmitic floor. It was therefore free from the objection, urged sometimes against Kent's Cavern, that having been known from time immemorial, and up to 1825 always open to all comers, it had perhaps been ransacked again and again.

2. It was believed, and it proved, to be a comparatively very small cavern; so that its complete exploration was not likely to require a large expenditure of time or of money.

It will be seen that the exploration was placed under circumstances much more likely to command attention than any of those which had preceded it. It was to be carried on under the auspices of the Royal and Geological societies by a committee consisting of Mr. S. H. Beckles, Mr. G. Busk, Rev. R. Everest, Dr. H. Falconer, Mr. Godwin-Austen, Sir C. Lyell, Professor Owen, Dr. J. Percy, Mr. J. Prestwich, Professor (now Sir A. C.) Ramsay, and myself, — all fellows of the Geological society, and almost all of them of the Royal society also.

It was impossible not to feel, however, that the mode of exploration must be such as would not merely satisfy those actually engaged in the work, but such as would command for the results which might be obtained the acceptance of the scientific world generally. Hence I resolved to have nothing whatever to do with 'trial pits' here and there, or with shafts to be sunk in selected places, but first to examine and remove the stalagmite floor, then the entire bed immediately below (if not of inconvenient depth), horizontally throughout the entire length of the cavern, or so far as practicable; this accomplished, to proceed in like manner with the next lower bed; and so on until all the deposits had been removed.

This method, uniformly followed, was preferable to any other, because it would reveal the general stratigraphical order of the deposits, with the amount and direction of such 'dip' as they might have, as well as any variations in the thickness of the beds; it would afford the only chance of securing all the fossils, and of thus ascertaining, not only the different kinds of animals represented in the cave, but also the ratios which the numbers of individuals of the various species bore to one another, as well as all peculiar or noteworthy collocations; it would disclose the extent, character, and general features of the cavern itself; it was undoubtedly the least expensive mode of exploration; and it would render it almost impossible to refer bones, or indications of human existence, to wrong beds, depths, or associations.

The work was begun in July, 1858, and closed at the end of twelve months, when the cavern had practically been completely emptied. An official report was printed in the *Philosophical transactions* for 1873, and all the specimens have been handed over to the British museum.

The paper on the subject mentioned at the beginning of this address was read in September, 1858, during the meeting of the association at Leeds, when I had the pleasure of stating that eight flint tools had already been found in various parts of the cavern, all of them inosculating with bones of mammalia, at depths varying from nine to forty-two inches in the cave-earth, on which lay a sheet of stalagmite from three to eight inches thick, and having *within* it and *on* it relics of lion, hyena, bear, mammoth, rhinoceros, and reindeer.

It soon became obvious that the geological apathy previously spoken of had been rather apparent than real. In fact, geologists were found to have been not so much disinclined to entertain the question of human antiquity as to doubt the trustworthiness of the evidence which had previously been offered to them on the subject. It was felt, moreover, that the Brixham evidence made it worth while, and indeed a duty, to re-examine that from Kent's Cavern, as well as that said to have been met with in river-deposits in the valley of the Somme and elsewhere.

The first-fruits, I believe, of this awakening, was a paper by Mr. Prestwich, read to the Royal society, May 26, 1859, on the occurrence of flint implements, associated with the remains of animals of extinct species in beds of a late geological period, — in France at Amiens and Abbeville, and in England at Hoxne (*Phil. trans.* for 1860, pp. 277-317). This paper contains explicit evidence that Brixham Cavern had had no small share in disposing its author to undertake the investigation, which added to his own great reputation, and rescued M. Boucher de Perthes from undeserved neglect. "It was not," says Mr. Prestwich, "until I had myself witnessed the conditions under which these flint implements had been found at Brixham, that I became fully impressed with the validity of the doubts thrown upon the previously prevailing opinions with respect to such remains in caves" (*Op. cit.*, 280).

Sir C. Lyell, too, in his address to the geological section of the British association, at Aberdeen, in September, 1859, said, "The facts recently brought to light during the systematic investigation, as reported on by Dr. Falconer, of the Brixham Cave, must, I think, have prepared you to admit that scepticism in regard to the cave evidence in favor of the antiquity of man had previously been pushed to an extreme" (*Report Brit. assoc.*, 1859, *trans. sects.*, p. 93).

It is probably unnecessary to quote further to show how very large a share the exploration at Brixham had in impressing the scientific world generally with the value and importance of the geological evidence of man's antiquity. That impression, begun, as we have seen, in 1858, has not only lasted to the present day, but has probably not yet culminated. It has

produced numerous volumes, crowds of papers, countless articles in reviews and magazines, in various countries; and perhaps, in order to show how very popular the subject became almost immediately, it is only necessary to state that Sir C. Lyell's great work on the 'Antiquity of man' was published in February, 1863; the second edition appeared in the following April; and the third followed in the succeeding November, — three editions of a bulky scientific work in less than ten months! A fourth edition was published in May, 1873.

Few, it may be presumed, can now doubt that those who before 1858 believed that our fathers had underestimated human antiquity, and fought for their belief, have at length obtained a victory. Nevertheless, every anthropologist has doubtless, from time to time,

"Heard the distant and random gun
That the foe was sullenly firing."

The 'foe,' to speak metaphorically, seems to consist of very irregular forces, occasionally unfair but never dangerous, sometimes very amusing, and frequently but badly armed, or without *any* real armor. The Spartan law which fined a citizen heavily for going into battle unarmed was probably a very wise one.

For example, and dropping a metaphor, a pamphlet published in 1877 contains the following passage: "With regard to all these supposed flint implements and spear- and arrow-heads found in various places, it may be well to mention here the frank confession of Dr. Carpenter. He has told us from the presidential chair of the Royal academy that 'no logical proof can be adduced that the peculiar shapes of these flints were given them by human hands'" (see 'Is the book wrong? a question for sceptics,' by Hely H. A. Smith, p. 26). The words ascribed to Dr. Carpenter are put within inverted commas, and are the whole of the quotation from him. I was a good deal mystified on first reading them; for while it seemed likely that the president spoken of was the well-known member of this association, Dr. W. B. Carpenter, it was difficult to account for his being in the presidential chair of the Royal academy, and not easy to understand what the Royal academy had to do with flint implements. A little search, however, showed that the address which Dr. W. B. Carpenter delivered in 1872 from the presidential chair of, not the Royal academy, but the British association, contained the actual words quoted, followed immediately by others which the author of the pamphlet found it inconvenient to include in his quotation. Dr. Carpenter, speaking of 'common sense,' referred, by way of illustration, to the 'flint implements' of the Abbeville and Amiens gravel-beds, and remarked, "No logical proof can be adduced that the peculiar shapes of these flints were given to them by human hands; but does any unprejudiced person now doubt it?" (*Report Brit. assoc.*, 1872, p. lxxv.) Dr. Carpenter, after some further remarks on the 'flint implements,' concluded his paragraph respecting them with the following words: "Thus what was in the first instance a matter of discussion, has now become one of those 'self-evident' propositions which claim the unhesitating assent of all whose opinion on the subject is entitled to the least weight."

It cannot be doubted, that, taken in its entirety (that is to say, taken as every lover of truth and fairness should and would take it), Dr. Carpenter's paragraph would produce on the mind of the reader a very different effect from that likely, and no doubt intended, to be produced by the mutilated version of it given in the pamphlet.

A second edition of the pamphlet has been given to the world. Dr. Carpenter is still in the presidential chair of the Royal academy, and the quotation from his address is as conveniently short as before.

It would be easy to bring together a large number of similar modes of 'defending the cause of truth,' to use the words of the pamphlet just noticed; but space and time forbid.

I cannot, however, forego the pleasure of introducing the following recent and probably novel explanation of cavern phenomena. In 1882 my attention was directed to two articles by one and the same writer, on 'Bone-cave phenomena.' The writer's theme was professedly the Victoria Cave, near Settle, Yorkshire, which he says was an old Roman lead-mine; but his remarks are intended to apply to bone-caves in general. He takes a very early opportunity, in the second article, of stating that "we shall have to take care to distinguish between what is truly indicated in the 'science' view from what are purely imaginary exaggerations of its natural and historical phenomena;" and he no doubt believes that he has taken this care.

"We have now," he says, "to present our own view of the Victoria Cave and the phenomena connected with it, premising that a great many of the old mines in Europe were opened by Phoenician colonists and metal-workers a thousand years before the Romans had set foot in Britain, which accounts for the various floors of stalagmite found in most caves, and also for the variety of groups of bones embedded in them. The animals represented by them, when living, were not running wild about the hills, devouring each other, as science men suppose, but the useful auxiliaries and trained drudges of the miners in their work. Some of them, as the bear, had simply been hunted, and used for food; and others of a fierce character, as the hyena, to frighten and keep in awe the native Britons. The larger species of mammalia, as the elephant, the rhinoceros, and hippopotamus, and beasts foreign to the country, the Romans, no less than the Phoenicians, had every facility in bringing with them in their ships of commerce from Carthage, or other of the African ports. These, with the native horse, ox, and stag, which are always found in larger numbers in the caves than the remains of foreign animals, all worked peacefully together in the various operations of the mines. . . . The hippopotamus, although amphibious, is a grand beast for heavy work, such as mining, quarrying, or road-making; and his keeper would take care that he was comfortably lodged in a tank of water during the night. . . . The phenomena of the Victoria Cave lead-mine differ in no

material respect from those of hundreds of others, whether of lead, copper, silver, or iron, worked in Roman and pre-Roman times in all parts of Europe. Its tunnels have all been regularly quarried and mined, *not by ancient seas*, but by the hands of historic man. Double openings have been made in every case for convenient ingress and egress during the process of excavation. Its roadways had been levelled, and holes made up with breccia, gravel, sand, and bones of beasts that had succumbed to toil, on which sledges, trolleys, and wagons could glide or run. . . . Near the entrance inside Victoria Cave were found the usual beds of charcoal, and the hearths for refining the metal; while close by, on the hillside, may still be seen the old kilns in which the men 'roasted' the metallic ores, and burned lime."

Should any one be disposed to ascribe these articles to some master of the art of joking, it need only be replied that they appeared in a religious journal (*The champion of the faith against current infidelity* for April 20 and May 11, 1882, vol. i. pp. 5 and 26), with the writer's name appended, and that I have reason to believe they were written seriously and in earnest.

It has been already intimated that Brixham Cavern has secured a somewhat prominent place in literature; and it can scarcely be needful to add that some of the printed statements respecting it are not quite correct. The following instances of inaccuracy may be taken as samples: —

The late Professor Ansted, describing Brixham Cavern in 1861, said, "In the middle of the cavern, under stalagmite itself, and actually entangled with an antler of a reindeer and the bones of the great cavern-bear, were found rude sculptured flints, such as are known to have been used by savages in most parts of the world" ('Geological gossip,' p. 209).

To be 'entangled' with one another, the antler, the bones of the cave-bear, and the flints, must have been all lying together. As a matter of fact, however, the antler was *on* the upper surface of the sheet of stalagmite, while all the relics of the cave-bear, and all the flints, were in detrital beds below that sheet. Again: the flints nearest the bear's bones in question were two in number: they were twelve feet south of the bones, and fifteen inches less deep in the bed. There was no approach to entanglement.

Should it be suggested that it is scarcely necessary to correct errors on scientific questions in works like 'Geological gossip,' professedly popular and intended for the million, I should venture to express the opinion that the strictest accuracy is specially required in such books, as the great majority of their readers are entirely at the mercy of the compilers. Those who read scientific books of a higher class are much more capable of taking care of themselves.

Professor Ansted's slip found its way into a scientific journal, where it was made the basis of a speculation (see *Geologist*, 1861, p. 246).

The most recent noteworthy inaccuracies connected with this famous cavern are, so far as I am aware, two in the English edition of Prof. N. Joly's 'Man before metals' (1883).

According to the first, "an entire left hind-leg of Ursus spelaeus was found lying above the incrustation of stalagmite which covered the bones of other extinct species and the carved flints" (p. 52).

It is only necessary, in reply to this, to repeat what has been already stated: all the bones of cave-bear found in the cavern were in beds *below* the stalagmite.

The following quotation from the same work contains the second inaccuracy, or, more correctly, group of inaccuracies, mentioned above: "We may mention, among others, the cave at Brixham, where, associated with fragments of rude pottery, and bones of extinct species, heaps of oyster-shells and other salt-water mollusks occur, as well as fish-bones of the genus Scarus" (p. 104).

I am afraid there is no way of dealing with this paragraph except that of meeting all its statements with unqualified denials. In short, Brixham Windmill-hill Cavern contained no pottery of any kind whatever, not a single oyster-shell, nor even a solitary bone of any species of fish. One common limpet-shell was the only relic of a marine organism met with in the cavern.

As already intimated, the result of the researches at Brixham quickened a desire to re-examine the Kent's Cavern evidence; and this received a considerable stimulus from the publication of Sir C. Lyell's 'Antiquity of man' in 1863. Having in the mean time made a careful survey of the cavern, and ascertained that there was a very large area in which the deposits were certainly intact, to say nothing of unsuspected branches which in all probability would be discovered during a thorough and systematic exploration, I had arrived at the conclusion, that, taking the cavern at its known dimensions merely, the cost of an investigation as complete as that at Brixham would not be less than £1,000.

Early in 1864 I suggested to Sir C. Lyell that an application should be made to the British association, during the meeting to be held at Bath that year, for the appointment of a committee, with a grant of money, to make an exploration of Kent's Cavern; and it was decided that I should take the necessary steps in the matter. The proposal being cordially received by the committee of the Geological section, and well supported in the committee of recommendations, a committee — consisting of Sir C. Lyell, Mr. J. Evans, Mr. (now Sir) J. Lubbock, Prof. J. Phillips, Mr. E. Vivian, and myself (honorable secretary and reporter) — was appointed, with £100 placed at its disposal. Mr. G. Busk was added to the committee in 1866, Mr. W. Boyd Dawkins in 1868, Mr. W. Ayshford Sanford in 1869, and Mr. J. E. Lee in 1873. The late Sir L. Palk (afterwards Lord Haldon), the proprietor, placed the cavern entirely under the control of the committee during the continuance of the work. The investigation was begun on March 28, 1865, and continued without intermission to June 19, 1880, the committee being annually re-appointed, with fresh grants of money, which in the aggregate amounted to £1,900, besides £63 received from various private sources.

The mode of exploration was essentially the same as that followed at Windmill Hill, Brixham; but as Kent's Cavern, instead of being a series of narrow galleries, contained a considerable number of capacious chambers, and as the aim of the explorers was to ascertain not merely what objects the deposits contained, but their exact position, their distribution, their condition, their collocation, and their relative abundance, the details had to be considerably more elaborate, while they remained so perfectly simple that the workmen had not the least difficulty in carrying them out, under my daily superintendence. The process being fully described in the First annual report by the committee (see *Report Brit. assoc.*, 1865, pp. 19, 20), it is unnecessary to repeat it here.

Mr. Godwin-Austen, while agreeing with Mr. MacEnery that flint implements occurred under the stalagmite, contended that they were found throughout the entire thickness of the cave-earth. MacEnery, on the other hand, was of opinion that in most cases their situation was intermediate between the bottom of the stalagmite and the upper surface of the cave-earth; and while admitting that occasionally, though rarely, they had been met with somewhat lower, he stated that the greatest depth to which he had been able to trace them was not more than a few inches below the surface of the cave-earth (*Trans. Devon. assoc.*, iii. 326, 327). The committee soon found themselves in a position to confirm Mr. Godwin-Austen's statement, and to say with him that "no distinction founded on condition, distribution, or relative position, can be observed whereby the human can be separated from the other reliquiae" (*Trans. geol. soc.*, 2d ser. vi. 444).

Mr. MacEnery's 'Plate F' contains seven figures of three remarkable canine teeth, and the following statement respecting them: "Teeth of Ursus cultridens, found in the cave of Kent's Hole, near Torquay, Devon, by Rev. Mr. MacEnery, January, 1826, in Diluvial Mud mix'd with Teeth and Gnaw'd Bones of Rhinoceros, Elephant, Horse, Ox, Elk, and Deer, with Teeth and Bones of Hyaenas, Bears, Wolves, Foxes, etc."

It is worthy of note, that no other plate in the entire series names the date on which the specimens were found, or the mammals with whose remains they were commingled. This arose probably from the fact, well known to MacEnery, that no such specimens had been found elsewhere in Britain; and possibly also to emphasize the statements in his text, should any doubt be thrown on his discovery.

It is, no doubt, unnecessary to say here that the teeth belonged to a large species of carnivore, to which, in 1846, Professor Owen gave the name of Machairodus latidens. MacEnery states that the total number of teeth he found were five upper canines and one incisor, and the six museums in which they are now lodged are well known.

A considerable amount of scepticism existed for many years in some minds, as to whether the relics just mentioned were really found in Kent's Cavern, it being contended, that, from its zoölogical affinities, Machairodus latidens must have belonged to an earlier fauna than that represented by the ordinary cave-mammals; and various hypotheses were invented to explain away the difficulty, most of them, at least, being more ingenious than ingenuous. Be this as it may, it was naturally hoped that the re-exploration of the cavern would set the question at rest forever; and it was not without a feeling of disappointment that I had to write seven successive annual reports without being able to announce the discovery of a single relic of Machairodus. Indeed, the greater part of the eighth report was written, with no better prospect, when, while engaged in washing a 'find' met with on July 29, 1872, I found that it consisted of a well-marked incisor of Machairodus latidens, with a left ramus of lower jaw of a bear, in which was one molar tooth. They were lying together in the first or uppermost foot-level of cave-earth, having over it a continuous sheet of granular stalagmite 2.5 feet thick. There was no longer any doubt of MacEnery's accuracy; no doubt that Machairodus latidens was a member of the cave-earth fauna, whatever the zoölogical affinities might say to the contrary; nor was there any doubt that man and Machairodus were contemporaries in Devonshire.

I cannot pass from this case without directing attention to its bearing on negative evidence. Had the exploration ceased on July 28, 1872, — the day before the discovery, — those who had always declined to believe that Machairodus had ever been found in the cavern would have been able to urge, as an additional and apparently conclusive argument, that the consecutive, systematic, and careful daily labor of seven years and four months had failed to show that their scepticism was unwarranted. Nay, more: had the incisor been overlooked, — and, being but a small object, this might very easily have occurred, — they might finally have said '15.25 years' labor;' for, so far as is known, no other relic of the species was met with during the entire investigation. In all probability, had either of these by no means improbable hypotheses occurred, geologists and paleontologists generally would have joined the sceptics; MacEnery's reputation would have been held in very light esteem, and, to say the least, his researches regarded with suspicion.

When its exploration began, and for some time after, the committee had no reason to believe or to suspect that the cavern contained any thing older than the cave-earth: but, at the end of five months, facts pointing apparently to earlier deposits began to present themselves; and, at intervals more or less protracted, additional phenomena, requiring apparently the same interpretation, were observed and recorded. But it was not until the end of three full years that a vertical section was cut, showing in undisturbed and clear succession, not only the cave-earth with the granular stalagmite lying on it, but, under and supporting the cave-earth, another, thicker and continuous, sheet of stalagmite (appropriately termed crystalline), and below this, again, an older detrital accumulation, known as the breccia, made up of materials utterly unlike those of the cave-earth.

The breccia was just as rich as the cave-earth in osseous remains, but the lists of species represented by the two deposits were very different. It will be sufficient to state here, that while remains of the hyena prevailed numerically very far above those of any other mammal in the cave-earth, and while his presence there was also attested by his teeth-marks on a vast number of bones; by lower jaws (including those of his own kith and kin), of which he had eaten off the lower borders as well as the condyles; by long bones broken obliquely, just as hyenas of the present day break them; and by surprising quantities of his coprolites, — there was not a single indication of any kind of his presence in the breccia, where the crowd of bones and teeth belonged almost entirely to bears.

No trace of the existence of man was found in the breccia until March, 1869, — that is, about twelve months after the discovery of the deposit itself, — when a flint flake was met with in the third foot-level, and was believed not only to be a tool, but to bear evidence of having been used as such (see *Report Brit. assoc.*, 1869, pp 201, 202). Two massive flint implements were discovered in the same deposit in May, 1872; and at various subsequent times other tools were found, until, at the close of the exploration, the breccia had yielded upwards of seventy implements of flint and chert.

While all the stone tools of both the cave-earth and the breccia were paleolithic, and were found inosculating with remains of extinct mammals, a mere inspection shows that they belong to two distinct categories. Those found in the breccia — that is, the more ancient series — were formed by chipping a flint nodule or pebble into a tool; while those from the cave-earth, the less ancient series, were fashioned by first detatching a suitable flake from the nodule or pebble, and then trimming the flake, not the nodule, into a tool.

It must be unnecessary to say that the making of nodule-tools necessitated the production of flakes and chips, some of which were no doubt utilized. Such flakes, however, must be regarded as accidents, and not the final objects the workers had in view.

It is worthy of remark, that in one part of the cavern, upwards of a hundred and thirty feet in length, the excavation was carried to a depth of nine feet, instead of the usual four feet, below the bottom of the stalagmite; and that, while no bone of any kind occurred in the breccia below the seventh foot-level, three fine flint nodule-tools were found in the eighth, and several flint chips in the ninth or lowest foot-level.

It may be added that the same fact presented itself in the lowest or corresponding bed in Brixham Windmill-hill Cavern. In short, in each of the two famous Devonshire caverns the archeological zone reached a lower level than the paleontological.

That the breccia is of higher antiquity than the cave-earth, is proved by the unquestionable evidence of clear, undisturbed superposition; that they represent two distinct chapters and eras in the cavern history, is shown by the decided dissimilarity of the materials composing them, the marked difference in the osseous remains they contained, and the strongly contrasted characters of the stone implements they yielded; and that they were separated by a wide interval of time, may be safely inferred from the thickness of the bed of stalagmite between them.

It is probable, however, that the fact most significant of time and physical change is the presence of the hyena in the cave-earth or less ancient, but not in the breccia or more ancient, of the two deposits. I called attention to this fact in a paper read to this department ten years ago (see *Report Brit. assoc.*, 1873, pp. 209–214), and at greater length elsewhere in 1875 (see *Trans. Plym. inst.*, v. 360–375). Bearing in mind the cave-haunting habits of the hyena, the great preponderance of his remains in the cave-earth, and their absence in the breccia, it seems impossible to avoid the conclusion that he was not an occupant of Britain during the earlier period.

The acceptance of this conclusion, however, necessitates the belief, 1°, that man was resident in Britain long before the hyena was; 2°, that it was possible for the hyena to reach Britain between the deposition of the breccia and the deposition of the cave-earth: in other words, that Britain was a part of the continent during this interval.

Sir C. Lyell, it will be remembered, recognized the following geographical changes within the British area between the newer pliocene and historical times (see 'Antiquity of man,' edition 1873, pp. 331, 332): —

Firstly, A pre-glacial continental period, towards the close of which the Forest of Cromer flourished, and the climate was somewhat milder than at present.

Secondly, A period of submergence, when the land north of the Thames and Bristol Channel, and that of Ireland, was reduced to an archipelago. This was a part of the glacial age, and icebergs floated in our waters.

Thirdly, A second continental period, when there were glaciers in the higher mountains of Scotland and Wales.

Fourthly, The breaking-up of the land through submergence, and a gradual change of temperature, resulting in the present geographical and climatal conditions.

It is obvious, that if, as I venture to think, the Kent's Cavern breccia was deposited during the first continental period, the list of mammalian remains found in it should not clash with the list of such remains from the Forest of Cromer, which, as we have just seen, flourished at that time. I called attention to these lists in 1874, pointing out, that, according to Professor Boyd Dawkins ('Cave-hunting,' p. 418), the forest-bed had at that time yielded twenty-six species of mammals, sixteen of them being extinct and ten recent; that both the breccia and the forest-bed had yielded remains of the cave-bear, but that in neither of them had any relic or trace of hyena been found. A monograph on the 'Vertebrata of the forest-bed series' was published in 1882 by Mr. E. T. Newton, F.G.S., who, including many additional species found somewhat recently, but eliminating all those about which there was any uncertainty, said, "We still

have forty-nine species left, of which thirty are still living and nineteen are extinct" (p. 135). Though the number of the species has thus been almost doubled, and the presence of the cave-bear remains undoubted, it continues to be the fact that no trace of the hyena has been found in the forest-bed. and no suspicion exists as to his probable presence amongst the eliminated uncertain species.

It should be added, that no relic or indication of hyena was met with in the 'fourth bed' of Brixham Windmill-hill Cavern, believed to be the equivalent of the Kent's Hole breccia.

I am not unmindful of the fact that my evidence is negative only, and that raising a structure on it may be building on a sandy foundation. Nevertheless, it appears to me, as it did ten years ago, strong enough to bear the following inferences: —

1. That the hyena did not reach Britain until its last continental period.

2. That the men who made the paleolithic nodule-tools found in the oldest known deposit in Kent's Cavern arrived during the previous great submergence, or, what is more probable, — indeed, what alone seems possible, unless they were navigators, — during the first continental period. In short, I have little or no doubt that the earliest Devonians we have sighted were either of glacial, or, more probably, of pre-glacial age.

It cannot be necessary to add, that while the discovery of remains of hyena in the forest-bed of Cromer, or any other contemporary deposit, would be utterly fatal to my argument, it would leave intact all other evidence in support of the doctrine of British glacial or pre-glacial man.

Some of my friends accepted the foregoing inferences in 1873; while others, whose judgment I value, declined them. Since that date no adverse fact or thought has presented itself to me; but through the researches and discoveries of others in comparatively distant parts of our island, and especially in East Anglia, the belief in British pre-glacial man appears to have risen above the stage of ridicule, and to have a decided prospect of general scientific acceptance at no distant time.

I must, before closing, devote a few words to a class of workers who are 'more plague than profit.'

The exuberant enthusiasm of some would-be pioneers in the question of human antiquity results occasionally in supposed 'discoveries,' having an amusing side; and not unfrequently some of the pioneers, though utter strangers, are so good as to send me descriptions of their 'finds,' and of their views respecting them. The following case may be taken as a sample: in 1881 a gentleman of whom I had never heard wrote, stating that he was one of those who felt deeply interested in the antiquity of man, and that he had read all the books he could command on the subject. He was aware that it had been said by one paleontologist to be "unreasonable to suppose that man had lived during the eocene and miocene periods," but he had an indistinct recollection that another eminent man had somewhere said that "man had probably existed in England during a tropical carboniferous flora and fauna." He then went on to say, "I have got that which I cannot but look upon as a fossil human skull. I have endeavored to examine it from every conceivable stand-point, and it seems to stand the test. The angles seem perfect; the contour, the same, but smaller in size than the average human head: but that, in my opinion, is only what should be expected, if we assume that man lived during the carboniferous period, in spite of what Herodotus says about the body of Orestes." Finally he requested to be allowed to send me the specimen. On its arrival, it proved, of course, to be merely a stone; and nothing but a strong 'unscientific use of the imagination' could lead any one to believe that it had ever been a skull, human or infrahuman.

It may be added, that a few years ago a gentleman brought me what he called, and believed to be, 'three human skulls, and as many elephants' teeth,' found from time to time during his researches in a limestone-quarry. They proved to be nothing more than six oddly-shaped lumps of Devonian limestone.

So far as Britain is concerned, cave-hunting is a science of Devonshire birth. The limestone-caverns of Oreston, near Plymouth, were examined with some care, in the interests of paleontology, as early as 1816, and subsequently as they were successively discovered. The two most famous caverns of the same county — one on the northern, the other on the southern, shore of Torbay — have been anthropological as well as paleontological studies, and, as we have seen, have had the lion's share in enlarging our estimate of human antiquity. The researches have, no doubt, absorbed a great amount of time and labor, and demanded the exercise of much care and patience; but they have been replete with interest of a high order, which would be greatly enhanced if I could feel sure that your time has not been wasted, nor your patience exhausted, in listening to this address respecting them.

LETTERS TO THE EDITOR.

Tree-growth.

The 'influence of winds upon tree-growth,' causing the asymmetry to which Mr. Kennedy calls attention in Science for Oct. 5, is noticeable to a remarkable degree among conifers in the mountains of the western half of the United States. The stunted, ground-hugging evergreens, which advance a little way above the limit of ordinary timber-growth on lofty mountains, are pressed to the earth by the steady gales as much as by overbearing snows, if not more. Evidence of this is found in the fact, that, where a cleft or little hollow occurs at or in advance of timber-line, the trees will stand straight and shapely within it as high as its rim (although in such nooks the snows lie longest and most deeply), above which they will be deformed, or unable to grow at all. This bending of the trees, the whole skirt of a forest, away from the edge of a precipice, or on a hilltop over which the wind sucks through the funnel of a cañon, is so common as to be seen every day by one travelling through the Rockies or the Sierra Nevada. It is particularly true in the Sierra San Joan, where the radiation of the vast adjacent sage-plains produces an

extraordinary suction upward, toward the chilly crests of that lofty range. I remember noticing it nowhere more strongly than on the coast of Sonoma county, Cal., swept by a constant indraught from the Pacific.

This was the locality of my article in *Harper's magazine* for January, 1883, styled 'In a redwood logging-camp.' In that article (p. 194), after speaking of the stiff, erect trunks of the Sequoia, as seen inland, I say, "In windy places, like the exposed sea-front, all the boughs are twisted into a single plane landward, and great picturesqueness results." As you look at these trees from a distance, you cannot resist the impression (however quiet the sea and the air) that a furious gale is at that moment straining every branch to leeward, as a March day does the garments of pedestrians, or the flags of the shipping in a harbor. The seashore parks of Victoria or Vancouver, and of San Francisco, give other examples of this same appearance. A conspicuous instance of this same thing is to be seen in the Salinas valley, which extends for over a hundred miles southward from Monterey. There a high point of view shows that every tree and bush (save large clusters) in the whole valley leans toward the south-east (approximately), urged by the terrific wind that never ceases to rush up the long valley from the sea to the hills.

It is needless, however, to seek examples so far away. A line of evergreens along the Greenwich River, in eastern Connecticut, shows the asymmetry produced by wind very plainly; and the shore-trees all along Montauk Point, and the low islands on that coast, are bent away from the sea. On any ocean coast (or equally along the Great Lakes), on wide plains, or in any lofty mountain-range, according to my pretty wide observation in the United States, one might tell the course of the prevailing winds as accurately as fifty years of signal-service observation, by a glance at exposed trees, which, nurtured in steady gales, bend in age as their sapling twigs were inclined.

Snow is another factor to be considered in regarding the growth of trees in mountain regions. The flattened thickets of spruce just above timber-line, of the same species which, in sheltered spots no lower down, assumes an erect and lofty attitude, are matted close to the ground by long weight of snow, as well as bowed beneath fierce gales. Many and varied examples of its effect might be adduced; but I will refer to one only. On the road to the anthracite mine above Crested Butte, in the Elk Mountains of Colorado, you pass through a large grove of aspens, some eighteen inches or more in diameter, standing thickly on the hillside, at an elevation of about nine thousand feet. That region is famous for its deep snows, which might be inferred from the fact that every tree in this broad aspen-grove is bent far out of the vertical, many of them thirty or forty degrees, and all uniformly as to direction. The only explanation of this is the snow, which weights them down through so many months of the year. The sturdier trunks rise vertically in many cases, but their tops arch over almost in a semicircle; while the saplings are bowed nearly to the ground. In many parts of the mountains, great swaths lie open in the woods, and can never (or at least do not) become forested on account of snow-slides; while the opposition of wind and snow together are the only conceivable reasons why many bare plateaus are not tree-grown; that, for example, between the Lake Fork of the Gunnison and Cochetopa Creek.

Ernest Ingersoll.

New Haven, Oct. 10, 1883.

Standard railroad time.

Though the subject of standard and uniform railway time has for some years been under consideration by various scientific and practical bodies, it does not appear in any way to have been exhausted, even in its main features. Besides, a certain bias has shown itself in favor of the adoption of a series of certain hourly meridians, and thus keeping Greenwich minutes and seconds, when contrasted with the practicability of a more simple proposition. There is also a feature in the discussion of the subject which bears to have more light thrown upon it; namely, what necessary connection there is between the railway companies' uniform time and the mean local time of the people, or the time necessarily used in all transactions of common life. Directly or by implication, certain time-reformers evidently aim at a standard time, which shall be alike binding on railway traffic as well as on the business community; and to this great error much of the complexity of the subject is to be attributed, and it has directly retarded the much-needed reform in the time-management of our roads.

We say all ordinary business everywhere must forever be conducted on local mean solar time, the slight difference between apparent and mean time having produced no inconvenience; and we may rightly ask the railway companies to give in their time-tables for *public* use everywhere and always, the mean *local* time of the departure and of the arrival of trains. It is the departure from this almost self-evident statement, and the substitution and mixing-up in the time-tables of times referred to various local standards, which has in no small measure contributed to the confusion and perplexity of the present system. The people at large do not care to know by what time-system any railroad manages its trains, any more than they care what the steam-pressure is, or what is the number of the locomotive All the traveller is interested in is regularity and safety of travel: hence it was to be desired, that, whatever the standard or standards of time adopted, the companies would refrain from troubling him with a matter which only concerns their internal organization, or which is entirely administrative. We look upon the publication of the railway time-tables, by local time everywhere, as a *sine quâ non* for the satisfactory settlement of the time question, so far as the public at large is concerned; and it would seem equally plain that the best system for the administration of railroads would be the adoption of a uniform time, this time to be known only to the managers and employees of the roads.

We are informed in Science of Oct. 12, that the solution of the problem of standard railway time is near at hand, and probably has already been consummated by the adoption of four or more regions, each having uniform minutes and seconds of Greenwich time, but the local hour of the middle meridian. To have come down from several dozen of distinct time-systems to a very few and uniform ones, except as to the hour, is certainly a step forward, and, so far, gratifying; but why not adopt Greenwich time, pure and simple, and have absolute uniformity? Probably this will be felt before long. The counting of twenty-four hours to the day, in the place of twice twelve, and the obliteration from time-tables of the obnoxious A.M. and P.M. numbers, would seem to be generally acknowledged as an improvement and simplification, and perhaps can best be dealt with by adopting it at once, accompanied by a simple explanatory statement.

C. A. Schott.

Washington, Oct. 18, 1883.

PACKARD'S PHYLLOPOD CRUSTACEA.

A monograph of the phyllopod Crustacea of North America, with remarks on the order Phyllocarida. By A. S. PACKARD, Jun. Author's edition, extracted from the twelfth annual report of the U. S. geological and geographical survey. Washington, 1883. 298 p., 39 pl., map. 8°.

ALTHOUGH Professor Packard began publishing upon the Phyllopoda long ago, and has for several years been well known to be engaged upon a monograph of the North-American species, the bulk of the work just published, and the profusion of its illustrations, are a great surprise. It is the most extensive, and in many ways the most important, monographic contribution to American carcinology; and, however we may criticise the execution of the work, every student of the American fauna must feel grateful to the author for undertaking and accomplishing it.

The work is much more than a systematic monograph of North-American Phyllopoda, as the following table of contents will show: I. Classification of the living Phyllopoda, which includes the systematic description of the North-American species; II. Geological succession, including descriptions of the North-American fossil species; III. Geographical distribution; IV. Morphology and anatomy; V. Development, metamorphoses, and genealogy; VI. Miscellaneous notes on the reproductive habits of Branchipodidae, by Carl F. Gissler; VII. The order Phyllocarida, and its systematic position; VIII. Bibliography; Appendix, consisting of translations or abstracts by Gissler, of papers by C. T. von Siebold, on Artemia fertilis from Great Salt Lake, and on parthenogenesis in Artemia salina; and by Schmankewitsch, on the relation of Artemia salina to Artemia Muehlhausenii and to the genus Branchipus, and on the influence of external conditions of life upon the organization of animals. There is some confusion between the titles of the principal divisions, which are given above, and the table of contents in the work itself. Scarcely any of the titles are the same; and, in place of 'Miscellaneous notes on the reproductive habits of Branchipodidae,' we have, in the table of contents, 'Relation to their environment; habits,'—subjects nowhere treated under a separate heading; and all reference to the long appendix is omitted.

About a fourth of the entire work is devoted to the systematic account of the species and higher groups of Phyllopoda, regarded by Professor Packard as a sub-order of Branchiopoda, which is made to include Cladocera and Ostracoda also. The Phyllopoda are divided as follows into families and sub-families, which include the number of recognized North-American genera and species nearly as indicated:—

LIMNADIIDAE:
- Limnetinae (1 genus, 4 species).
- Estheriinae (3 genera, 11 species).

APODIDAE (2 genera, 9 species).

BRANCHIPODIDAE:
- Branchipodinae (5 genera, 12 species).
- Thamnocephalinae (1 genus, 1 species).

All the groups are described; nearly all the species are figured, many of them very fully; and important notes on variability and habits are given for some of the species. Artemia gracilis is treated more at length than any other species, and is made to include all the described North-American species; but, in regard to its relation to the European A. salina, there is certainly confusion, as the following paragraphs show.

"Upon comparing our species with the European, it is difficult to find good differential characters, as the portions of the body where specific differences would be expected to occur are liable to considerable variation. Upon comparing a number of females from Great Salt Lake with a number of females of the maleless generation from Trieste, Austria, received from Professor Siebold, there are really no differences of importance. Our A. gracilis (Verrill's fertilis) is slighter, with a smaller head; and perhaps the second antennae are a little slighter in build; I see no essential difference in the form of the ovisac, while the shape of the legs, especially the sixth endite, is essentially the same" (p. 331).

"On comparing a number of Salt Lake females with individuals of the same sex of the European Artemia salina, our species was found to be undoubtedly specifically distinct; the Utah specimens are slenderer, smaller, and the sixth endite of all the feet considerably slenderer and longer in proportion than in A. salina. The ovisacs were of the same proportion but slenderer, and the head is slighter and smaller in our American species" (p. 333).

Different conclusions on neighboring pages, in regard to the specific identity of closely allied forms, might be accounted for in a careless author; but differences like these in statements of observation betray inexplicable carelessness.

In the chapter on geological succession, a table of the geological and geographical distribution of the known fossil species is given, and also a diagram indicating the geological his-

tory of the orders of Crustacea, the sub-orders of Branchiopoda, and the families of Phyllopoda. It is said that this diagram "may also serve as a genealogical tree, showing the probable origin of the main divisions of the Crustacea:" but the genealogical part of the diagram consists simply of dotted lines connecting the points of first appearance in geological history of the Branchipodidae, Apodidae, and Cladocera, with the point of appearance of the Limnadiidae in the Silurian; the common stem from this point with the Ostracoda in the upper Laurentian; and the branchiopod stem thus formed, and continued to a hypothetical Protonauplius in the lower Laurentian, with the points of appearance of the Malacostraca, Phyllocarida, and Cirripedia. On what conceivable theory of evolution this would represent a possible, much less the probable, origin of the main divisions of the Crustacea, it is hard to imagine, and was probably not seriously considered by the author himself; for it is far less like a probable genealogical tree than the diagram on p. 448, illustrating the relations of the Phyllocarida to other Crustacea.

In the chapter on morphology and anatomy, Professor Packard discusses at length the morphology of the regions of the body and the appendages of Arthropoda in general, and of the crustacean limb in particular, and gives some account of the anatomy of the phyllopods, but adds very little to our previous knowledge of the anatomy of the group. The morphological discussion is an interesting contribution to the subject, and, with the numerous figures with which it is illustrated, will prove very useful, although most of the new nomenclature proposed for the regions of the body and appendages is very objectionable. Professor Packard says, "For the primary regions of the head (*sic*), the only scientific terms as yet in use are those proposed by Prof. J. O. Westwood, in Bate and Westwood's History of British sessile-eyed Crustacea (vol. i. p. 3). These are *cephalon* for the head, *pereion* for the thorax, and *pleon* for the abdomen; while the thoracic feet are termed *pereiopoda*, and the abdominal legs *pleopoda;* the three terminal pairs being called *uropoda*. As the names applied to the thorax and abdomen have no especial morphological significance, the Greek *περαιον*, simply meaning ulterior, and *πλεον*, more, we would suggest that the head be termed the *cephalosome*, the cephalic segments, *cephalomeres*, and the cephalic appendages in general, *protopoda*, the term 'cephalopoda' being otherwise in use. The thorax of insects and of most Crustacea might be designated the *baenosome* (*βαινω*, to walk, locomotion), and the thoracic appendages, *baenopoda*, the segments being called *baenomeres;* while *urosome* might be applied to the abdomen, the abdominal segments being called *uromeres*. Westwood's term *uropoda* might be extended so as to include all the abdominal appendages." If mere names of parts are to be rejected, simply for want of 'morphological significance,' the language of the morphologist would soon become a meaningless jargon, to which it is near enough already; but, even as to 'morphological significance,' there appears to be little choice between the new and old terms. Bate, when first proposing the terms 'pereion'[1] and 'pleon,' expressly states that he derives the terms from *περαιόω* ('*to walk about*') and *πλέω* (*navigo*). The proposed term 'protopoda' is quite as unfortunate as 'cephalopoda,' since 'protopodite' and 'protopod' are already in use for parts of crustacean appendages, the former even in the present work. The extension of the term 'uropoda' so as to make it synonymous with 'pleopoda' would also be unfortunate, since, as now employed, it is a very useful term to designate the modified caudal pleopoda, whether one, two, or three pairs.

In the chapter on development, metamorphoses, and genealogy, Professor Packard gives a short account of the nauplius form in Phyllopoda as an introduction to Dr. Gissler's interesting notes in the following chapter, and then briefly discusses the phylogeny of the group, in which he appears to find but one difficulty. He says, —

"The difficulty is (and this is a point apparently overlooked by Fritz Müller, Dohrn, Claus, and Balfour) to account for the origination of the phyllopods at all from any marine forms. The only explanation we can suggest, is that the phyllopods have arisen through Limnetis directly from some orginally marine cladocerous type like the marine forms now existing, such as Evadne. We imagine that when a permanent body of fresh water became established, as, for example, in perhaps early Silurian times, the marine forms carried into it in the egg-condition, possibly by birds or by high winds, hatched young, which, under favorable conditions, changed into Sida, Moina, and Daphnia-like forms."

Professor Packard appears to have overlooked the difficulty of the eggs of any marine cladocerous type of animals surviving a sudden transfer from salt to fresh water, and the

[1] According to either Bate's or Packard's derivation, this would be more properly written *peraeon*, as has sometimes been done, or even *pereon*.

absence of birds in the Silurian, which might well deter the boldest speculator from offering such an explanation; but when we consider that permanent bodies of fresh water were undoubtedly formed by the gradual freshening of bodies of salt water cut off from the ocean, and that such bodies of fresh water usually had outlets connecting them with the sea, it is not surprising that Fritz Müller, Dohrn, and others should overlook a difficulty which is no greater for Phyllopoda than for other groups of fresh-water animals.

In the chapter on his new order, Phyllocarida, and its systematic position, Professor Packard describes the anatomy and development of Nebalia, and discusses its fossil allies. The appendages of Nebalia bipes are described and fully figured, but on the internal anatomy very little that is new is given. The figures and text intended to elucidate the histology, like most of Professor Packard's similar work, leave much to be desired.

The bibliography consists of a hundred and thirty-eight titles, divided into four sections, — one for living and one for fossil Phyllopoda, and the same for Phyllocarida. The titles of many of the works referred to are omitted in the bibliography, which is evidently very incomplete; but its incompleteness is not so annoying as the entire want of system in its arrangement, and the frequency of typographical errors.

Typographical errors are very numerous in all parts of the work; and many of them cannot properly be charged to the proof-reader, who, however, ought to have corrected blunders like 'Yahresbericht' (several times) and 'zoogloical,' and the inexplicable punctuation of most of the bibliographical references in the systematic parts of the work. Errors due to careless writing or careless compiling are more common than purely typographical errors, and far more confusing. On p. 313 we have the following: "It is difficult to say whether this is a Limnadia or Estheria, as the description is too brief and inexact to enable us to determine the genus or species. It cannot be a Limnadia, and seems to approximate more closely to Estheria; though it cannot belong to that genus." On p. 335 it is said that 'Schmankevitch' found 'Branchinecta ferox (Fischer sp.)' transform by artificial means into Artemia; but in reality he found an Artemia change into a Branchinecta, or into what he considered a Branchipus. On p. 337, 'Labrador examples' are said to have been taken 'on the north side of Hamilton Inlet, Northern Greenland.' On pp. 313 and 314 the species of Estheriinae not recognizable are inserted between two species of Eulimnadia instead of at the end of the sub-family. Two paragraphs at the bottom of p. 349, under Streptocephalus Sealii, should have been placed under Chirocephalus Holmani, on p. 352. On pp. 356 to 358 the genus Leaia is inserted between two species of Estheria.

The plates, perhaps the most valuable part of the work, are nearly all lithographs from the establishment of Thomas Sinclair & son, and are apparently accurate representations of the original drawings. The general figures, mostly drawn by Emerton and Burgess, are excellent. The figures of details, drawn by the author, are not always so satisfactory: the figures of the appendages of Apus and Lepidurus, for example, are very rudely drawn, and badly arranged on the plates. Unfortunately, the amount of enlargement of scarcely any of the figures is given. S. I. SMITH.

SIR WILLIAM LOGAN.

Life of Sir William E. Logan, Kt., LL.D., F.R.S., F.G.S., etc., first director of the Geological survey of Canada. By BERNARD J. HARRINGTON, B.A., Ph D., professor of mining in McGill university. Montreal, *Dawson Bros.*, 1883. With steel portrait and numerous woodcuts. 432 p. 8°.

A LIFE of Logan will be greeted by all geologists as a fit companion for those which have recently appeared of his English colleagues, Lyell and Murchison. What they did for Great Britain, he did for his native Canada, and even more. He solved the most complicated geological problems in vast areas where no white man had ever trod before him. He forced his way through trackless forests, making his own surveys and maps as he proceeded, and, in spite of such difficulties, not only discovered the structure of a greater part of his own country, but gave to the world a new series of formations. The work of Murchison and Sedgwick he completed by carrying order and succession beyond the Silurian and Cambrian, into that chaos of still older rocks, thus rendering the soil of his beloved Canada forever classic in geological annals.

The author of the present memoir has given us Sir William's history almost in his own words. By means of judicious extracts from his voluminous correspondence and journals, chronologically arranged, we are presented with a charming picture of the man, as well as the *savant*, all the more faithful because it is unconsciously given. Here we see portrayed

an indomitable will, the keenest power of observation, as well as the coolest judgment in drawing conclusions, rare tact in managing his fellow-men, a ready sense of humor, combined with those subtler qualities of heart which make a man *beloved* wherever he may be. The author has rendered his work doubly attractive by making it sort of an unintentional autobiography.

Sir William Edmond Logan was born in Montreal, April 20, 1798, and remained at home until he was sent to the Edinburgh high school, in 1814. He studied at the high school and university of this place until 1817, when he entered upon a mercantile life in London, which he continued during the following fourteen years. In 1831 he was placed in charge of a copper company, near Swansea, in Wales, where he exhibited for the first time his geological proclivities. This company mined its own coal, and it was through this fact that he was led to his first really scientific investigations. He prepared a map of the South Wales coal-district with a degree of accuracy which had hardly before been equalled by any geological workers. This map attracted much attention from De la Beche, and other of England's most prominent geologists, and secured him influential friends who ever remained true to him.

In 1840 Logan returned to his native land, and spent over a year in studying the coal formation in New Brunswick and Pennsylvania. The results of his investigations relating to the origin of coal *in situ* were published soon after he returned to England. The subject of a government geological survey had been for some time under discussion in Canada, when, in 1841, £1,500 was appropriated for this purpose; and in the following year Logan received, upon the recommendation of his friends De la Beche, Murchison, Buckland, and Sedgwick, the appointment of director. During the seasons of 1843–44 he devoted his attention to studying the peninsula of Gaspé, where coal had been reported, and, in an incredibly short time, unravelled the geological complexities of a vast wilderness. The coal was not found, but its absence from the Silurian and Devonian rocks which compose that region was placed beyond a doubt.

But notwithstanding the energy with which Logan's work was carried on, and the success which attended it, his efforts to awaken in his countrymen an interest in geological pursuits were for a long time not appreciated. Years of doubt and anxiety followed the opening of the survey; and it was only through the indomitable will and consummate tact of its director that the opposition of a short-sighted government was finally overcome, and its permanent existence assured.

Although nothing was more foreign to Sir William's character than a taste for display, or a desire for fame, he fully appreciated the advantages to the survey and to Canada which must arise from having the results of his work widely known. Thus it was that he willingly undertook the charge of the Canadian exhibit at three world's fairs, — London in 1851 and 1862, and Paris in 1855, — and was more than repaid for his untiring exertions by the success which attended them. He saw, largely through his own efforts, an active interest in his native land awakened in Europe, the knowledge of her resources extended, and her industries and wealth thereby increased; while these practical results of his own work secured to him the encouragement of his countrymen, and honors poured fast upon him from all quarters. His appropriations were increased year by year; the best specialists were associated with him in different departments, such names as Hunt, Murray, and Billings, adding no little lustre to the survey's name; the field of work was extended over all of Canada that was accessible; and ample opportunity was given for the publication of scientific results.

Into the details of Sir William's special work we have here no time to enter: suffice it to say, that the sphere of his labors was very varied, as the list of his memoirs appended to the present work will show, his discoveries numerous and important, and all that he accomplished most thoroughly and accurately done. But the survey was always his especial care; and he may well have considered his life's work performed, when, at his resignation from the directorship in 1869, he could leave it upon a permanent footing, provided with every facility for future activity and usefulness. To the close of his life, his interest in its work never abated; and his last thoughts were devoted to completing some of his investigations begun as its director.

In August, 1874, Sir William once more went to England, and died the following June, at his sister's house in Wales. As a geologist, he will always be honored in the scientific world; while, as a man and as a friend, he will long be remembered by those who were never able to appreciate his work.

A very valuable paper on the history of the rocks of the Quebec group, by Principal Dawson of McGill college, forms a most welcome addition to this, of itself, so interesting book.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

The divisions in Saturn's rings. — Professor Kirkwood, in 1868, accounted for the great division in Saturn's rings by the commensurability of the period of a body revolving at that distance from Saturn with the periods of the six inner satellites. Dr. William Meyer of Geneva has investigated every possible combination of the commensurabilities of the revolution periods of the satellites, and finds six other places where a perturbing influence is exercised. The divisions most strongly marked seem to be at places where the commensurabilities are the closest, and all the satellites take part. A faint division should be found in the inner bright ring, according to Dr. Meyer. Prof. Holden has noted a distinct point at which the shading-off begins, in the position indicated by Meyer's theory, — a fact which seemed to have escaped Meyer's notice. — (*Observ.*, Sept., trans. from *Astr. nachr.*, 2,527, with additions.) M. McN. [306

Saturn. — Dr. William Meyer of Geneva gives a new determination of the orbits of six of Saturn's satellites, — Enceladus, Tethys, Dione, Rhea, Titan, and Iapetus. From each of these he has determined the mass of Saturn, the reciprocal value of the combined result being $M = 3{,}482.9 \pm 5.5$. The original observations are to appear in the *Mémoires de la société de physique de Genève* during the present year. — (*Astr. nachr.*, 2,528.) M. McN. [307

MATHEMATICS.

Functions of a complex variable. — In the present paper, entitled 'Applications of Fourier's theorem to the theory of the functions of a complex variable,' M. Harnack first shows in what manner the Fourier series are to be employed in the discovery of a rigid basis for the Cauchy-Riemann theorem concerning the development of functions of a complex variable. A generalization is also given of the fundamental hypothesis involved in the C.-R. theorem, as follows: if w is a function of $x + iy$, which over a simply connected plane region is everywhere continuous, and which 'in general' satisfies the differential equation, —

$$\frac{dw}{dx} + i\frac{dw}{dy} = 0,$$

then the function w is with its derivatives everywhere finite and continuous, and will possess no singular points. The term 'in general' (*im allgemeinen*) means that the points which do not satisfy the above differential equation, together with the points for which the partial derivatives $\frac{dw}{dx}$ and $\frac{dw}{dy}$ are indeterminate between finite or infinite limits, or are discontinuous, shall make up simply a discrete system of curves. In the second part of the paper, the author has gone very briefly into the subject of the representation of an analytical function, without singularities, in the interior of a circle by aid of Dirichlet's principle. — (*Math. ann.*, xxi.) T. C. [308

ENGINEERING.

Heavy engines and American railroad-tracks. — Mr. O. Chanute states that heavy 'consolidation' engines do not injure the track more than the lighter engines formerly did. Trains have been lengthened from 22 cars in 1874 to 38 in 1883; and the weights hauled, from 106 to 228 tons. By strengthening draw-heads, links, and pins, accidents from breaking apart of trains have been diminished, and the cost of haulage has been reduced from one cent to a half-cent per ton per mile. — (*Mechanics*, July 28.) R. H. T. [309

The British institution of mechanical engineers. — This society held its summer meeting in Belgium. It was received by the Association of engineers of Liége university, and visited the principal engineering establishments of the country. President Westmacott, in his opening address, called attention to the progress recently made in the rapid production of good articles of manufacture, and to the fact that speed and excellence of work are not incompatible where machinery is used. The materials must be of the best quality, however, the machines well proportioned, and all working parts well balanced and well fitted. He referred to Thorneycroft's experience with torpedo-boats, and called attention to the fact, that, at high speeds, the difficulties of lubrication and the jar observed at lower speeds disappear. In the speed of railway-trains, no advance has been lately made, and the maximum speeds remain at the figures of earlier years. Some economy has been obtained by the use of the crude products of the distillation of petroleum in the fireboxes of locomotives, this economy sometimes amounting to fifty per cent. Cotton-machinery has been speeded up, until the spindles which formerly made 5,000 revolutions are now making from 8,500 to 10,000, on fine American cotton. The increase in speed of woollen-machinery has not been great. In gunnery, the weight of gun and projectile have increased, in twenty-five years, from 5 tons and 66 pounds to 100 tons and 2,000 pounds. The shot has an initial energy of nearly 50,000 foot-tons. High speed is the direction of change in all departments of engineering. — (*Nature.*) R. H. T. [310

Hardening soft limestones with fluosilicates. — The application of alkaline silicates to the exterior of buildings, in order to prevent the deterioration of the stone, has not been attended with satisfactory results. H. L. Kessler proposes to use a solution of fluosilicates of bases whose oxides and carbonates are insoluble in a free state. When soft limestone is saturated with a concentrated solution of a fluosilicate of magnesium, aluminum, zinc, or lead, a very considerable degree of induration is soon reached, and the resulting products, except the liberated carbonic anhydride, are less soluble than the stone itself. No varnish is formed, and therefore no danger arises from expansion of frost beneath it. The process has

resisted the severe tests of winter. Colors may be introduced satisfactorily. — (*Les mondes; Amer. arch.*, Sept. 1.) C. E. G. [311

CHEMISTRY.

(General, physical, and inorganic.)

The yellow and red plumbic oxides. — A study of the formation and properties of the two forms of plumbic oxide, by A. Geuther, shows that it is dimorphous, the yellow modification crystallizing in rhombic forms, and the red in the tetragonal system. The yellow oxide is changed by pressure and by friction into the red form, which is again transformed into the yellow, when heated to its melting point. — (*Ann. chem.*, ccxix., 56.) C. F. M. [312

Artificial reproduction of barite, celestite, and anhydrite. — A. Gorgeu finds that the sulphates of barium, strontium, and calcium dissolve freely in the melted chlorides of various metals at a red heat. On cooling, they separate in well-defined crystals which resemble closely the natural sulphates. From the results of his experiments, M. Gorgeu concludes that the minerals barite, celestite, and anhydrite must have been deposited from a solution of their amorphous sulphates in some metallic chloride. — (*Comptes rendus*, xvi. 1734.) C. F. M. [313

A modification of V. Meyer's apparatus for vapor density determinations. — In order to obtain a uniform temperature, H. Schwarz surrounds the tube containing the substance with a jacket which serves as an air-bath. The required temperature is obtained by placing the apparatus in an ordinary combustion-furnace. — (*Berichte deutsch. chem. gesellsch.*, xvi. 1051.) C. F. M. [314

METEOROLOGY.

Barometric laws. — The weather review issued by the *Deutsche seewarte* contains not only summaries of the weather conditions in each month, and of the work of the bureau in connection with them, but also occasional articles of scientific value, based upon the observations. The number for the year 1882 contains a valuable paper entitled *Typische witterungserscheinungen*, the object of which is to discuss the laws governing the velocity and direction of the movement of areas of low pressure, and their attendant phenomena, deduced from European observations between 1876 and 1880. The low areas during this period are grouped into five classes, according to the directions of the paths which they pursued. The accompanying charts exhibit, for each of three positions of the storm-centre (the entrance, middle position, and departure, as regards the territory of western Europe), six attendant phenomena, — the distribution of pressure and temperature, barometric changes in the preceding twenty-four hours, temperature departures from the normal, amount of precipitation, and cloud-phenomena. Tables are also given showing the distribution of the storm-tracks, with respect to the time of year, the average depth of the depressions, and their velocity.

The discussion to which the charts and tables have been subjected brings out various empirical laws, which are of special aid to the officers of the *seewarte* in their weather forecasts, as well as of scientific interest. Several of these may be mentioned: 1°. The depressions usually advance in the direction of the strongest winds. 2°. The line of advance of the depression forms an angle with the line of greatest increase of temperature, which generally lies between 45° and 90°, the highest temperature lying at the right of the path of the minimum. In summer the angle is greater than in winter, often reaching 90°. Both of these laws conform to the principles laid down in 1872 by Ley. They may be combined into one as follows: "The onward movement of the depressions follows approximately in the direction of the preponderating movement of the whole mass of air in the vicinity of the depression." The importance of cloud-studies, especially of the upper clouds, consists in the fact that their direction of movement foreshadows, in a general way, the direction of movement of the depression. On the other hand, their distribution in advance of the depression is so irregular that their indications cannot be relied upon alone, but must be combined with the distribution of pressure and other meteorological conditions.

The most interesting part of the discussion relates to the distribution of pressure at the height of 2,500 metres. The barometric readings are reduced to this height (in addition to the usual reduction to sea-level) by means of Köppen's formula, published in 1882; the first use of this method which has yet been published, as far as known. At this height the minima are not so closely enclosed by the isobars as is indicated by the charts; and it is shown, that "the rotary motion is limited to the lower atmospheric strata, in which the axis of the vortex is inclined towards the left and apparently somewhat forward." It seems that an advance in our knowledge of barometric movements might be made by further attention to this method of research, which enables us to investigate the extent of a depression in a vertical direction as well as in the horizontal direction, to which investigation has hitherto been limited. — (*Monatl. übersicht witterung*, 1882.) W. U. [315

GEOGRAPHY.

(Arctic.)

Polar stations. — The Austrian steamer Pola reached Jan Mayen, Aug. 3, and found the party in excellent health and spirits. We have already announced their safe return to Vienna. Some account of the wintering is given in *Nature*, from which we learn, that, in 1882, the autumn storms began with a heavy snowfall about the end of August. September was fine and warm; October again stormy. The polar night began Nov. 12, and ended Jan. 30. Aurora was constant and of great brilliancy during the winter. The greatest cold (−63° F.) was observed in January, but March had the lowest average temperature. Terrible snow-storms occurred at intervals; the ice, which first formed around the island in December, being frequently broken up, and the salt spray carried a long distance inland. The ice dis-

appeared by the end of June. There had been no illness, and the international programme had been perfectly carried out. —— In addition to the international stations, the physical laboratory at Upsala has made simultaneous observations for the year ending Aug. 15. —— The Swedish expedition arrived at Tromsö from Spitzbergen, Aug. 28. The year's observations were completed Aug. 23. No casualties had occurred among the members of the party, and the relieving vessel encountered no ice of consequence. —— The Dutch, party which wintered in the Varna, near Waigatz Strait, arrived at Hammerfest, Sept. 3. The Varna was nipped Dec. 24, 1882, but did not founder until July 24, 1883. One of the crew died during the winter. The observations, except those relating to magnetism, were carried on with success. After the vessel sank, the party was accommodated on the Dimfna, from which it was taken by the steamer Obi, and carried to Vardö. Hovgaard, in the Dimfna, was confident of getting into open water in August, but intended, if he did not succeed in doing so by Aug. 15, to despatch half the crew under Lieut. Olsen for Yalmal on the Siberian coast, while he remained on the vessel with the other half during the winter. The Dimfna has since arrived at Vardö. —— No attempt is to be made to reach Greely's party this year, as the season is considered too late. Several Eskimo stories have reached civilization, and have been supposed to refer to that party. It is certain that they are entitled to no credence whatever, in the shape in which they are received, even if originally based on some actual fact, which is doubtful. —— The Point Barrow party under Ray has been successfully relieved, and reached San Francisco, Oct. 7. According to a telegram from Lieut. Ray, all work was accomplished except the pendulum observations. The relieving schooner Leo reached Point Barrow, Aug. 22, but was forced away by the ice the same night; returned on the 24th, but was again forced to retire, with some damage, the next day. On the 27th, however, the party and stores were embarked, and the vessel reached Unalashka, where she was beached and repaired. Lieut. Schwatka and party, who had descended the Yukon from the Chilkat country to the sea, and reached St. Michael's safely, were brought to San Francisco by the Leo. — W. H. D. [316

The whaling-season. — Reports from Bering Strait to latest dates still continue to characterize the season as the worst and most icy for many years. No serious casualties had occurred since the loss of the John Howland. — W. H. D. [317

Arctic notes. — The death of Admiral Sir Richard Collinson, at the age of seventy-two, is announced. He commanded the Franklin search expedition, 1850–54, on the Enterprise and Investigator, surveyed Minto Inlet and Prince Albert Sound in 1852. Part of his command under M'Clure, by walking from their vessel in Mercy Bay, over the ice to the Resolute at Dealy Island, and afterwards sailing for England on the North Star, made the north-east passage from the Pacific for the first and only time. Collinson received the gold medal of the Royal geographical society, the order of the Bath, and had been deputy-master of Trinity House since 1875. —— The latest news from the polar station at the Lena mouth was to the effect that all were well April 3, though the winter had been very trying. The lowest temperature observed was —52°.3 F., Feb. 9. The deviation of the magnetic needles was very great, especially during 'magnetic storms,' reaching 25° in azimuth in the declinometer, and 90° for the suspended magnet in observations for horizontal intensity. —— The newspaper accounts of Lieut. Schwatka's voyage are so confused, and contain so many absolute errors, that it is difficult to know exactly what they are intended to convey. The facts appear to be, that he crossed the portage from the Chilkat River to the Kussooa affluents of the Lewis River, as several parties of prospectors have done before him. The descent was then made to the Yukon, at Fort Selkirk, on rafts. Some of the Indians of the party becoming mutinous, it is reported that three of them were killed by Schwatka; and the party then descended the river from the site of Fort Selkirk to Fort Adams, just below Nüklükahyet', about longitude 152° 30' west, where one of the river-boats used in trading was chartered to take them to the seacoast. It is to be hoped that astronomical observations have been made by the party, which, so far as merely traversing the country is concerned, has done no more than has been done by different parties of prospectors and explorers before; none of whom, however, obtained any observations of precision on the river above Fort Yukon. —— Lieut. Stoney, U.S.N., after delivering the presents to the Chukchi of St. Lawrence Bay, which were sent in return for their benevolence to the officers and men of the Jeannette search expedition, on the U.S.S. Rodgers, landed near Hotham Inlet, and, according to newspaper reports, attempted to explore one of the three large rivers which fall into this estuary. The information given by the daily press is not exact; but it appears that the chief work accomplished was the collection of some native reports in regard to one of these rivers, which, in the state they have been made public, are incompatible with the known geography of the region. Doubtless, in this as in the case of Lieut. Schwatka's party, when the official reports are received, they will be found to contain welcome additions to our knowledge of these regions. [318

BOTANY.

Color-changes of lungwort flowers. — Dr. Müller finds, that while occasionally insects visit the blue (older) flowers of Pulmonaria officinalis, but without benefit to themselves or the plant, the red (younger) flowers are much more frequently visited for pollen and nectar, being at the same time fertilized. One female of Anthophora pilipes, for example, was seen to visit only red flowers, or those just beginning to change. Another visited, at first, both red and blue flowers, but later, apparently learning by experience that the blue flowers contain no nectar, confined her visits to the red flowers. A third visited in the following order: sixteen red flowers of Pulmonaria, one blue Nepeta glechoma, twenty-three red Pulmonaria, one Nepeta, twenty-

one red Pulmonaria, and one Nepeta. Coming, now, to a place where the ground-ivy prevailed, she visited sixty-one Nepeta flowers, then five red Pulmonaria flowers, after which she returned to her nest. Earlier observation has also shown that this bee is not constant in its visits to a given species. The visits of the second individual and of one or two other insects, watched but a short time, to the blue flowers, is attributed to their lack of experience on this species; while the promiscuous visits of others are believed to be due to a noticeable confusion which was manifested after one or two unsuccessful visits had been made to flowers drained by earlier comers. From his observations, the writer concludes that the blue color of the older flowers, like the final color of those of Ribes aureum and Lantana, is of twofold advantage to the plant, — on the one hand increasing the conspicuousness of the flower-cluster, while, on the other hand, it indicates to the more acute of the visiting insects the flowers to which their attentions should be confined for their own good and that of the plant. — (*Kosmos*, 1883, 214.) W. T. [319

Insects versus fertilization. — In some notes on Thripidae, Mr. Osborn discusses the food-habits of these minute insects, believing, from the structure and position of their mouth-parts, and such observations as he has been able to make, that the major part of the group are vegetable feeders, the few species considered by Walsh and Riley as insectivorous differing in this respect from most of their congeners. Even these are thought to possibly seek the honey-dew of aphides, etc., rather than to destroy them.

Of young apple-blossoms frequented by them, "eighty per cent were injured by punctures upon the styles and other parts, but particularly the styles; and all the evidence pointed to the thrips as the cause of injury," though they were never seen to actually puncture the tissue. — (*Canad. entom.*, Aug.) W. T. [320

ZOÖLOGY.

Origin of individuality in the higher animals. — H. Fol has published a very interesting note, in which he studies, not the historical or phylogenetic, but the physiological, origin of the individual. The questions proposed are, At what moment in the ontogeny is the individuality created and limited? What factors determine the development of one, two, or several embryos from a single vitellus? The cases of double monsters by union of two distinct eggs, and polymerism, being phenomena of a different order, do not come into consideration here.

Fol's new researches were made principally on the sea-urchin, Strongylocentrotus lividus, which is strictly individualized at all stages of its existence. He had previously reached the conclusion that normal fecundation demands only one spermatozoon for each egg. Selenka thinks that two or three do not involve the sequel of an irregular development. Fol has verified both points, and finds that normal fecundation may be effected by either one or two spermatozoa uniting with the egg-nucleus. Three seem to produce abnormalities. The spermatozoon, then, does not act as an individuality: it represents only a certain dose of nuclear substance; and the dose may be either single or double. Immature or injured eggs admit several spermatozoa. Very ingeniously Fol has produced such a condition temporarily by immersing the mature ova for a moment in water saturated with carbonic acid, then transferring them to well-aerated water, and impregnating. The half-asphixiated eggs admit each three or four spermatozoa, which unite with the female pronucleus, after which follows an abnormally long period of repose. When segmentation begins, there appears a complex caryolytic figure, with three or four poles instead of two, a triaster or tetraster, or two parallel amphiasters, separate or united. The number of segmentation-spheres formed is at least double the normal. The larvae have irregular forms, and often two or three gastrular cavities.

If the eggs are more completely under the influence of the carbonic acid, from five to ten spermatozoa may gain entrance. The earliest comers unite with the female pronucleus: the later ones remain in the periphery. The nucleus forms a tetraster or double amphiaster; and the peripheral male pronuclei form each an amphiaster, which usually join end to end, forming a rosary of asters and spindles. Each of these amphiasters seems to be a centre of development, for the surviving larvae are polygastric.

These facts lead to the conclusion that neither the egg, nor the female pronucleus, nor the spermatozoon, suffices, taken separately, to determine the individuality. The dose of nuclear substance resulting in the formation of an embryo may vary within considerable limits; and the number of amphiasters at the first cleavage is the first criterion which decides the number of individuals. Fol then considers the first amphiaster of segmentation as the first fact of individuality. [Fol does not appear to have demonstrated a strict correspondence between the number of amphiasters and of individuals. His view raises the question whether there is a fundamental difference between the bipolar (amphiasters) and multipolar asters in cell-division.] — (*Comptes rendus acad. Paris*, Aug. 13, 1883.) C. S. M. [321

VERTEBRATES.

Birds.

The white of birds' eggs. — Tarchanoff has discovered that the white of the eggs of those birds whose young are born unfeathered differs from ordinary albumen, its most striking peculiarity being that it remains transparent after coagulation by heat. He designates it as 'tata-eiweiss.' It differs from ordinary white of egg in many respects. When coagulated it is fluorescent. It has less polarizing power, and contains more water, than the white of hens' eggs. It gives no precipitate when abundantly diluted with water. It is at first strongly alkaline, but loses that reaction as the yolk develops. It is rapidly digested. It can be redissolved in water after drying at 40° C. It can be changed into what appears to be identical with ordinary albumen, *a*, by the addition of a few drops of concentrated solutions of neutral salts of alkaline bases, or, *b*, of concen-

trated acetic or lactic acid; *c*, under the influence of carbonic acid at a temperature near boiling; *d*, by incubation (owing to the action of the CO_2 excreted by the yolk? — *Rep.*). Experiments left it uncertain whether the ordinary albumen first passes through the 'tata' form. It seems probable that the 'tata-eiweiss' is a sodic or potassic albuminate. — (*Pflüger's arch. physiol.*, xxxi. 368.) C. S. M. [322

Yolkless artificial eggs. — Tarchanoff, in the course of his experiments, noticed in the preceding abstract, made fistulae of the oviduct in hens. They bear the operation well, but it causes atrophy of the glands of the oviduct, and apparently of the ovary also. The mature ova are discharged into the body-cavity. Under favorable circumstances, if a ball of amber is introduced into the upper end of the duct, the white with fully developed chalazae, and the membranous shell, are deposited, producing a normally formed egg, in which the yolk is replaced by the amber ball. A ligature prevented the descent of the egg, during the experiment, into that region of the oviduct which secretes the calcareous shell. — (*Pflüger's arch. physiol.*, xxi. 375.) C. S. M. [323

ANTHROPOLOGY.

Notes on New Guinea. — By degrees this unknown land is being brought before the scientific world. Mr. W. G. Lawes, writing from Port Moresby, describes a visit to the Rouna Falls, accompanied by his wife, the first lady to tread the unbeaten tracks of New Guinea. In the district of Sogere the travellers stopped at several native villages. The one where they camped consisted of seven houses and three tree-houses, which are really forts or castles. One was a hundred and twenty feet high. A native went up with an armful of spears, and threw them down at an imaginary enemy. When they have reason to expect an enemy, they take up a supply of big stones. These houses command the whole village, and could not easily be taken. The travellers saw much of the natives, who are good specimens of the average Koiarian. They are somewhat darker, shorter, and more hairy, than the coast people. When a man dies, it is always known whose spirit has bewitched him; and his tribe must pay in order to give the dead man rest. Whenever a man of the least consequence dies, there is fighting. Their mode of getting fire is peculiar. They take a dry stick of pithy wood, and split it a little way. In the cleft they put a piece of wood or a stone to keep it open; then, putting a little rubbish as tinder under the split part of the stick, they stand on the other end, and pass a strip of rattan, cane, or bamboo, under the cleft, drawing it rapidly up and down, when it soon begins to smoke, and sparks appear between the forks of the stick, which, with a little care, sets fire to the tinder, and a flame is soon obtained. — J. W. P. [324

The Toltecs. — Notwithstanding Dr. Brinton's consignment of the Toltecs to the Morgenland, M. E. T. Hamy has the courage to say, "The Toltecs play the most important part in the past history of North America. Their history commences with the fifth century of our era, and their migration to the south-east coincides in a striking manner with the great movement of peoples in the old world. When the Goths and Huns were annihilating the civilization of Europe, at the other end of the world other barbarians, travelling in the same direction, were destroying older nations." M. Hamy gives a brief review of the Toltec art, especially in clay, and then proceeds to enlarge upon the discoveries of M. Charnay, illustrating his remarks by means of specimens in the Lorillard collection. The first period of Toltec ceramic art is termed *pastillage*; the second, more advanced, may be called *poussage*. Tula, Teotihuacan, and Cholula contain the most imposing vestiges of Toltec grandeur. The remains of what was the first capital of the Toltecs are situated nineteen leagues north of Mexico, at the confluence of the Rio Grande de Tula and a small river from the mountains of Texas. M. Charnay visited the ruins of this place, and photographed the most important. The descriptions of the other two capitals are passed over briefly by M. Hamy; but of Cholula, fortunately, we have the very minute observations of Bandelier, to be published by the Archeological institute. — (*Assoc. sc. France*, Conférence 25 Mars, 1882.) J. W. P. [325

The perforated humerus. — Professor Henry W. Haynes, in exhibiting a perforated Indian humerus found at Concord, Mass., brings together some important references to the same phenomenon observed elsewhere. Mr. Henry Gilman found 50 % in the Michigan mounds; at Grenelle, Paris, M. Martin found 28 %; in the Furfooz race of the caves of Belgium, M. Dupont found 30 %; in the Dolmen of Argenteuil, near Paris, M. Leguay found 25 %; while Dr. Pruner Bey ascertained the average at Vaureal, near by, to be 26 %. He also reported that it is common in skeletons of the Guanches. In the cave of Orrouy, belonging to the bronze age, the average was ascertained by Dr. Broca to be 25 %. Among two thousand skeletons of the polished stone age, discovered by the Baron de Baye in Champagne, he reports it as very frequent. Prof. Ward also speaks of the broken state in which long bones are found, attributing it to design. With regard to percentages on small numbers, a very singular experience was that of the writer of this note last year. Wishing to know what races and nationalities supplied the criminals of his city, he consulted the census and the police records. The former reported one Persian in the community; the latter, five Persians, arrested and convicted. Startled by the fact that five hundred per cent of the Persians were criminals, he was about to warn the government against allowing any more to land. A few moments' study, however, set the matter right. The poor Persian on the census-roll had been 'sent down' five times during one year, for sixty days each time, on account of vagrancy. — (*Proc. Amer. antiq. soc.*, ii. 80.) O. T. M. [326

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

National museum.

Publications. — The publications of the museum are issued under two titles, — 'Bulletins' and 'Proceedings.' The bulletins consist of monographs of groups of animals, plants, or minerals; papers upon the fauna, flora, and minerals of different regions of the globe; and similar works. The proceedings contain shorter communications descriptive of new species, etc., or relating to novel phenomena. All papers are based on material in the museum. Five volumes of the proceedings, and twenty-two bulletins, have already been published, aggregating 7,396 octavo pages. The sixth volume of the proceedings, and several bulletins, are now in course of publication. The bulletins which will appear within a short period are the following: —

A bibliography of the writings of Professor Spencer Fullerton Baird, by G. Brown Goode, A.M.; Avifauna columbiana, by Elliott Coues and D. Webster Prentiss, M.D.; A contribution to the natural history of Bermuda, edited by G. Brown Goode, A.M.; A manual of herpetology, by Henry C. Yarrow, M.D.; Official catalogue of the collections exhibited by the U. S. national museum at the London fisheries exhibition, 1883.

The exhibition-halls. — Two very important objects are about to be placed on exhibition in the museum. The first of these is a group of orangs, mounted by Mr. William T. Hornaday. The group represents a fight in the treetop, in which are concerned two adult male orangs, and as spectators a female and baby, and a young male. The setting has been worked out with great care, especially as regards the nests of the orangs, the foliage, vines, orchids, etc. All the specimens were shot by Mr. Hornaday in Borneo, and are mounted from his notes upon the living and fresh specimens.

The second object of interest is an antique Roman mosaic derived from Carthage. It was exhibited at the Centennial exhibition in the Tunisian section, and was afterward presented to the museum by Sir Richard Wood, British consul-general at Tunis. The mosaic represents a lion of life-size, seizing an animal resembling a horse or ass. It is believed to date from the first century B.C.

Additions to the collections. — The museum has recently secured a very valuable collection of archeological objects from Missouri, comprising twenty-five specimens. Included among them are a digging-implement of peculiar shape, and about a foot long, and two hourglass-shaped ceremonial objects of pink quartz about four inches long. Among the recent accessions to the department of birds is a nest of Opornis agilis, with eggs, — the first specimen of which there is authentic record. The department of reptiles is at present negotiating for a specimen of the very rare North-American serpent, Ophthalmidium longissimum. The department of mammals has received a valuable accession in the form of partially complete skeletons of eleven sperm whales. They represent the remains of a small school of these cetaceans, which stranded near Cape Canaveral, Florida, in the winter of 1882–83.

Bureau of ethnology.

Pueblo of Tallyhogan. — Mr. James Stevenson reports that careful investigations in the vicinity of the abandoned pueblo of Tallyhogan, in the ancient province of Tusayan, Arizona territory, disclose the fact that the sand-dunes on the north and east of the village were used by the former inhabitants as burial-places. A very little digging exposed the remains of the interred, which were usually placed in a hole in a doubled-up, mummy-like attitude.

In many cases vases and bowls, which probably contained food, were inhumed with the dead, and in some instances trinkets were found.

A number of old specimens were secured, among them being small images of human beings (previously unknown to collectors in this region), curious in workmanship, and ancient in ornamentation.

NOTES AND NEWS.

MR. G. K. GILBERT has recently given some rather disturbing suggestions to the people of Salt Lake City (*Salt Lake weekly tribune*, Sept. 20) concerning the probability of destructive earthquakes there. He describes the slow and still continuing growth of the ranges in the Great Basin by repeated dislocation along great fractures, the earth's crust on one side being elevated and tilted into mountain attitude by an upthrust that produces compression and distortion in the rocky mass, until the strain can no longer be borne, and something must give way. Suddenly and violently there is a slipping of one wall of the fissure on the other, far enough to relieve the strain, and this is felt as an earthquake; then follows a long period of quiet, during which the strain is gradually reimposed. Such a shock occurred in Owen's valley, along the eastern base of the Sierra Nevada, in 1872, when a fault-scarp five to twenty feet high and forty miles long was produced. A scarp thirty or forty feet high is known along the western foot of the Wahsatch range, south of Salt Lake, and other scarps of similar origin have been found at the bases of many of the Basin ranges. The date of their formation is not known; but it must be comparatively recent, because they are still so little worn away. Wherever they are fresh, and consequently of modern uplift, there is probable safety from earthquakes for ages to come, because a long time is needed for the accumulation of another strain sufficient to cause a slipping of one wall of the fissure on the other. Conversely, when they are old and worn down, the breaking strain may even now be almost reached, and an earthquake may be expected at any time. This is the case at Salt Lake; for, continuous as are the fault-scarps along the base of the Wahsatch, they are absent near this city. From the Warm Springs to

Emigration Cañon they have not been found, and the rational explanation of their absence is that a very long time has elapsed since their last renewal. In this period the earth-strain has been slowly increasing. Some day it will overcome the friction, lift the mountains a few feet, and re-enact on a fearful scale the catastrophe of Owen's valley.

— The president of the International committee Dr. H. Wild, by request of the governments concerned, has announced that the observations of the parties at the circumpolar observing stations were to cease, as was originally planned, in September, 1883, and the different expeditions will return as shortly thereafter as practicable.

— Violent solfataric disturbances were experienced in Iceland between the 12th and 21st of last March.

— The English government has decided to establish an astronomical and meteorological observatory at Hong Kong, and has appointed Dr. William Doberck director of the institution. Dr. Doberck has accepted the position, and removed to Hong Kong. He may be addressed through the Crown agents for the Colonies, Downing street, London.

— In the *Journal of chemical industry* of June 29, Mr. G. W. Wigner, F.C.S., F.T.C., gives an account of the damage done to delicate substances by the material in which they are packed, suitability being too often sacrificed to strength, lightness, or mere ornament. As president of the society of public analysts, Mr. Wigner has had many opportunities of studying the subject.

Oysters, he writes, have been imported into England in barrels made of wood containing a very large proportion of tannin, with results which can be better understood than appreciated. The iron contained in the liquor has produced a very noticeable proportion of ink, and the oysters themselves have become converted into a poor but certainly novel kind of leather. Tinned fish and tinned acid fruits have been packed in vessels in which lead predominated over tin to a very marked extent. He alluded to the loss in cargoes of essences and scents by the impossibility of making the stoppers of glass bottles absolutely air-tight, and the damage done to other parts of the cargo by those essences. Mr. Wigner then proceeds to describe the effects of evaporation in the hold of a ship: bilge-water can never be quite excluded, and change of temperature must produce evaporation; the dew thus produced settles on the top of the packing-cases, and in time corrodes the metal, or is absorbed, as the case may be, and, if the voyage be long enough, damages the goods. Canned goods, he writes, seldom remain good for a second season, even if apparently well packed: the tin, some of the iron, and the lead contained in the tin, are dissolved, and the contents of the can become contaminated with these metallic substances.

The greater part of Mr. Wigner's article is devoted to the effects produced on tea by the wood in which it is packed. The Chinese formerly used 'toon' wood only; but the forests have been so much cut down that the supply is running short, and in Assam, wood for packing-cases is cut at random. In one instance, a consignment of Assam tea had a distinctive odor of its own, resembling a new and excessively rank kid glove; some hundreds of chests being thus damaged. The inner lead coating of tea-chests used by the Chinese is much purer, and less liable to damage by acid, than the lighter lining used by the dealers in upper India.

— Professor Angelo Heilprin was elected one of the curators of the Academy of natural sciences of Philadelphia on Oct. 2, to supply the vacancy caused by the death of Mr. Charles F. Parker. At a meeting of the council, held Oct. 5, Professor Heilprin was appointed actuary to the curators or curator in charge. He has commenced the arrangement of a department of the museum to be devoted exclusively to the natural history of Pennsylvania and New Jersey. The geology and mineralogy, together with the fauna and flora, of the two states, will be represented as completely as possible, and will form a collection which cannot fail to be of special interest to local students.

— The papers read at the meeting of the Biological society of Washington, Oct. 19, were by Dr. Theodore Gill, The ichthyological results of the explorations of the U. S. fish-commission steamer Albatross in 1883; Dr. C. A. White, Character and function of the epiglottis of the bull-snake (Pityophis); Professor Lester F. Ward, Note on an interesting botanical relic of the District of Columbia; Dr. C. V. Riley, Manna in the United States.

— The Philosophical society of Washington, on Oct. 13, held its first session after the summer vacation. Since June it has lost three members by death, — Surgeon-Gen. C. H. Crane, who was one of its vice-presidents; Admiral B. F. Sands, one of the original founders of the society; and Dr. Josiah Curtis. The papers of the evening were by Mr. William B. Taylor, on the Rings of Saturn; by Dr. Swan M. Burnett, on the Character of the focal lines in astigmatism; and by Mr. H. A. Hazen, on Thermometer-exposure.

— A scientific session of the National academy of sciences will be held in New Haven, at Yale college, commencing on Tuesday, Nov. 13.

— Mr. F. W. Putnam, of the Peabody museum, Cambridge, announces his readiness to give lectures on American archeology, based upon the course delivered last year before the Lowell institute. His subjects cover such matters as the shell-heaps, caves, mounds and earthworks, stone graves, pueblos, and ancient arts and religious rites of our country, as well as general sketches of the archeology of North America, Mexico and Central America, South America, and Peru.

— At the meeting of the Engineers' club of Philadelphia, Oct. 6, Mr. Edward Thiange presented an illustrated description of a method of earthwork computation, by means of diagrams constructed from the proposition, 'The areas of similar figures are to each other as the squares of their homologous sides.' An idea may be had of their nature and uses by the following directions: to get the average volume in cubic yards of a station (in embankment), to the cen-

tre-fill at each end add the constant height of the 'grade triangle' (which is formed by the road-bed and the side-slopes produced); at the resultant heights on the diagram, measure, with the scale of cubic yards, the lengths of the ordinates terminated by the slope-lines at each station respectively; their sum, diminished by the 'grade prism,' is the average quantity for the station of one hundred feet.

— A paper upon Economy in highway bridges, by Prof. J. A. L. Waddell, was read. Its objects are to determine the most economical depth and number of panels for spans from forty to two hundred feet; the lengths at which it is better to change from pony truss to thorough bridge, and from single to double intersection; the exact dead loads, and the amounts of lumber and iron for each case.

— Mr. Lester F. Ward has published in the U. S. fish-commission bulletin a list of the marsh and aquatic plants of the northern United States, which will be useful to those interested in aquaria and fish-ponds. The list numbers a hundred and eighty-one species, sixty-one of which are strictly aquatic, the balance being found in marshy places. Three species are said by Dr. Hessel to be injurious to carp-ponds; viz., Nuphar advena, Nuphar sagittaefolium, and Bidens Beckii. The species recommended especially for carp-ponds are of the strictly aquatic genera, Utricularia and Potamogeton. Of the Compositae, only three species, all Bidens, are given as being marsh-loving, or aquatic.

— The director of the Imperial Japanese government laboratory at Yokohama, Dr. A. J. C. Geerts, died there Aug. 30, aged forty.

— We have just received intelligence of the death of the distinguished French paleontologist, Dr. Joachim Barrande.

RECENT BOOKS AND PAMPHLETS.

Bacharach, M. Abriss der geschichte der potentialtheorie. Göttingen, *Vandenhoeck & Ruprecht*, 1883. 3+78 p. 8°.

Bericht, offizieller, über die im königlichen glaspalaste zu München 1882 stattgehabte internationale elektricitäts-ausstellung, verbunden mit elektrotechnischen versuchen. Red. W. v. Beetz, O. v. Miller, E. Pfeiffer. Leipzig, 1883. 244+154 p., illustr. 4°.

Bernstein, H. A. Dagboek van de laatste reis van Ternate naar Nieuw-Guinea, Salawati en Batanta 1864–65, uitgavet door S. C. van Musschenbroek. Met aanteekeningen, bijlagen en kaart. 's Gravenhage, 1883. 258 p., map. 8°.

Biehringer. Schematische darstellung elektrodynamischer maschinen. 2 chromolithogrische wandtafeln. Nürnberg, 1883. f°.

Blakesley, T. H. Electricity at the board of trade. London, *Low*, 1883. 24 p. 8°.

Block, J. Origines de l'electricité, de la lumière, de la chaleur, et de la matière. Nancy, 1883. illustr. 8°.

Brown, J. C. Finland: its forests and forest management. London, *Simpkin*, 1883. 306 p. 8°.

Chastaingt, G. Catalogue des plantes vasculaires des environs de La Châtre (Indre). Châteauroux, 1883. 199 p. 8°.

Cracau, J. R. B. Ob und wann? Ein versuch zur beantwortung der frage nach der möglichkeit und dem zeitpunkte des weltunterganges. Braunschweig, *Graff*, 1883. 33 p. 8°.

Dahl, F. Analytische bearbeitung der spinnen Norddeutschlands. Kiel, 1883. 100 p., illustr. 8°.

D'Arzano, A. Les habitants de la mer et la flore marine. Limoges, 1883. 120 p. 12°.

Dietrich, R. Die darstellung der wurzeln der algebraischen gleichungen durch unendliche reihen. Inaug. diss. Jena, *Deistung*, 1883. 44 p. 8°.

Dubois, A. Croquis alpins, avec une notice sur la flore alpestre, par F. Crepin. Bruxelles, 1883. 519 p., illustr. 8°.

Elektrotechnische rundschau. Illustrirte zeitschrift zur verbreitung nützlicher kenntnisse aus dem gebiete der angewandten elektricitätslehre. Red. Stein. heft 1. Halle, 1883. illustr.

Fabri, R. Impressioni della esposizione di elettricità a Parigi; con aggiunte che si riferiscono al primo Congresso internazionale degli elettricisti. Santagata, *Feltria*, 1882. 140 p. 16°.

Fleck, H. Ueber die chemie in ihrer bedeutung für die gesundheitspflege. Berlin, 1883. 8°.

Gaffron, E. Beiträge zur anatomie und histologie von Peripatus. Inaug. diss. Breslau, *Köhler*, 1883. 32 p. 8°.

Galle, A. Berechnung der proximitäten von asteroidenbahnen. Inaug. diss. Breslau, *Köhler*, 1883. 60 p. 8°.

Glaischer, J. Factor table for the sixth million: containing the least factor of every number not divisible by 2, 3, or 5, between 5,000,000 and 6,000,000. London, *Taylor*, 1883. 4°.

Gustave, F., et **Héribaud-Joseph**, F. Flore d'Auvergne, contenant la description de toutes les plantes vasculaires qui croissent spontanément dans les département du Puy de Dôme et du Cantal, des clefs analytiques et un vocabulaire des termes employés. Clermond-Ferrand, 1883. 624 p. 16°.

Hauck, W. Ph. Die grundlehren der elektricität mit besonderer rücksicht auf ihre anwendungen in der praxis. Wien, 1883. 293 p., illustr. 8°.

Hauftmann, C. Bedeutung der keimblättertheorie für die individualitätslehre und den generations-wechsel. Inaug. diss. Jena, *Deistung*, 1883. 41 p. 8°.

Henneguy, Ch. Les lichens utiles. Paris, 1883. 120 p., illustr. 8°.

Hess, E. Einleitung in die lehre von der kugelteilung mit besonderer berucksicht ihrer anwendung auf die theorie der gleichflächigen und der gleicheckigen polyeder. Leipzig, *Teubner*, 1883. 10+475 p., 16 pl. 8°.

Hjelt, E. Grunddragen af allmänna organiska kemin. Helsingfors, 1883. 160 p. 8°.

Kallenbach, E. Polynoë cirrata O. Fr. Mllr. Ein beitrag zur kenntniss der fauna der Kieler Bucht. Inaug. diss. Jena, *Deistung*, 1883. 38 p., 1 pl. 8°.

Kauffmann, G. Ueber den β-naphtolaldehyl und seine derivate die β-naphtolcarbonsäure und das β-naphtolcumarin. Inaug. diss. Breslau, *Köhler*, 1882. 37 p. 8°.

Krämer, J. Die elektrische eisenbahn bezüglich ihres baues und betriebes. Wien, 1883. (Elektro-techn. bibl. xvii.) illustr. 8°.

Kremser, V. Die bahn der 2 cometen von 1879. Inaug. diss. Breslau, *Köhler*, 1883. 43 p. 8°.

Kuntze, O. Phytogeogenesis. Die vorweltliche entwickelung der erdkruste und der pflanzen in grundzügen dargestellt. Leipzig, 1883. 240 p. 8°.

Lankester, E. The cholera: What is it? and How to prevent it. London, *Routledge*, 1883. 8°.

Lista, R. Mis esploraciones y descubrimientos en la Patagonia 1877–80. Buenos Aires, 1883. 213 p., illustr. 8°.

Love, G. H. Étude sur la constitution moléculaire des corps, sur les lois des volumes moléculaires, des chaleurs spécifiques et des dilatations. Précédée d'une introduction sur la définition de la loi et celle de la force. Paris, 1883. 2 pl. 8°.

M., M. K. The birds we see, and the story of their lives. N.Y., *Nelson & sons*, 1883. 3+93 p., illustr. 16°.

Macé, E. Les Lycopodiacées utiles. Paris, 1883. 80 p. 4°.

Macgregor, J. L. L. The organization and valuation of the forests on the continental system in theory and practice. London, 1883. 318 p. 8°.

Manson, P. The Filaria sanguinis hominis, and certain new forms of parasitic disease in India, China, and warm countries. London, *Lewis*, 1883. illustr. 8°.

Microscopical science, studies in. Ed. by A. C. Cole. vol. 1. London, *Bailliere*.

Netto, Ladislau. Aperçu sur la théorie de l'évolution. Conférence faite à Buenos-Ayres le 25 Oct. 1882. Rio de Janeiro, *imp. Messager du Brésil*, 1883. 6+22 p. 8°.

Neumann, C. Hydrodynamische untersuchungen, nebst einer anhang über die probleme der elektrostatik und der magnetischen induction. Leipzig, *Teubner*, 1883. 40+320 p. 8°.

Oldbricht, C. Beiträge zur kenntniss der einwirkung von trocknem ammoniakgas auf geschmolzenes chlorzink, chlorcadmium und chlornickel. Inaug. diss. Breslau, *Köhler*, 1883. 33 p. 8°.

Paetel, F. Catalog der conchyliensammlung von F. Paetel. Berlin, *Paetel*, 1883. 3+271 p. 8°.

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